Volume 26, Number 6

OCTOBER 1959

THE SCIENCE TEACHER

JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION

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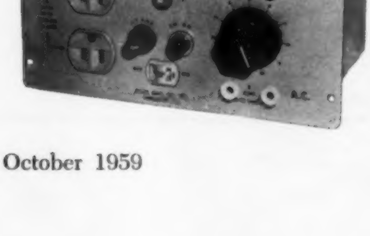

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THE SCIENCE TEACHER

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Volume 26, Number 6 **October 1959**

Editor's Column

This month I wish to discuss briefly some questions which have been posed relative to purposes and practices for NSTA meetings other than our national convention. These would include our annual summer meeting with NEA, the regular winter meeting with AAAS, and the two or three regional meetings held in October and November.

1. *How should NSTA regional meetings be planned?* This year's regional meetings in Concord, New Hampshire, and in New York City represent a new design for NSTA. These developed as work-conferences on a rather specific subject—the planning of K-12 programs in science. In addition to serving the regions where held and the conference participants themselves, these meetings will be important "feeders" of ideas and opinions for the Kansas City convention. Is such a design preferable to a wide open meeting?

2. *What should be the nature of the NSTA meeting with AAAS?* For over ten years, NSTA and other science teaching societies of the AAAS have planned jointly for meetings during the period December 27-30. Cooperation and coordination of these program sessions have produced important and beneficial results. There is a question, however, as to whether NSTA is missing a golden opportunity for closer liaison with scientists and scientific societies of AAAS. Should we schedule fewer individual sessions of our own (or perhaps none) in favor of providing time and encouragement for teachers to attend more sessions of the various AAAS-affiliated scientific societies? Should we seek joint planning with some of these scientific groups to develop sessions which will reveal more clearly the relations between advances in current science and the problems of curriculum and instruction at pre-college levels? Should sessions be sought in which scientists may learn about, react to, and advise on various NSTA projects such as the STAR awards, on-the-job research experiences for teachers, Science Achievement Awards for students, and others?

3. *How should the NSTA meeting with NEA each summer be planned?* Just as we may be neglecting opportunities to meet with the scientists, so we may be missing opportunities (or shirking a duty) to work toward better understanding and cooperation with our colleagues from other segments of the educational profession. The summer meeting of NEA would seem to be an ideal time for this, attended as it is by teachers, administrators, curriculum specialists, and college people. Should questions of "balance in the curriculum," time and facilities for science, coordination of science instruction with social studies, mathematics, and health, be discussed only among ourselves, or should we seek to enlarge the forum?

You are invited to give consideration to these points and write and express your opinions. It should be added that our annual convention is not immune to the same kind of critical review, so if you have thoughts and recommendations on this activity, please send them along, too.

Robert H. Carleton

THE SCIENCE TEACHER

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Readers' Column

We thought it would please you to know we found more interest this year at the convention in Atlantic City than we ever have before. The official registration attendance was given as 1,704. Of this number we signed up 537 people at our booth for free supplementary teaching material. I believe you will agree this is a very high percentage.

MAY LIPTON
Scientific and Health Information
The National Foundation
New York City

I appreciate your materials, for they help me keep aware of what is going on in the science education field while I'm away in the U. S. Navy.

RICHARD LEVIN
Staff Commander
NAS Navy 14, c/o FPO
San Francisco, California

A Criticism of the PSSC* Course

Now that we have been hearing and thinking about, and trying out, the PSSC course in physics for more than a year, some comments about it may be in order from a classroom teacher who gave it careful attention, but who, admittedly, has not been one of the try-out group.

I have heard some private criticisms of PSSC from fellow teachers, but all public and printed utterances about the course contain nothing but praise, often bordering on the fulsome. It does indeed take temerity to stand up to MIT, NSF, *et al* and point out shortcomings.

I should like to reserve final judgment until the experiment with PSSC is farther along and I have had a chance to teach it. There are, however, some aspects of the course which I feel need correction, or at least more careful consideration than I have seen evidenced thus far.

1. Much of the language and some of the concepts in the textbooks are too difficult, even for the top 25 per cent of the high school population for which the course is supposedly intended. My guess is that these books were written by college teachers. Although "some of my best friends, etc.," I think college teachers cannot write for high school pupils. My experience of a quarter century of teaching science convinces me that the best texts are written by teachers who are actually teaching the boys and girls for whom their books are intended. College teachers might act as consultants or co-authors, but the actual writing should be done by a teacher well versed in physics and gifted in writing for the secondary school pupil.

2. There are not enough applications of principles of physics in PSSC. I quite agree that physics—1959 should not be merely a course in technology, but this should not rule out the teaching of life situations where a principle being taught may be applied. One

(Continued on page 448)

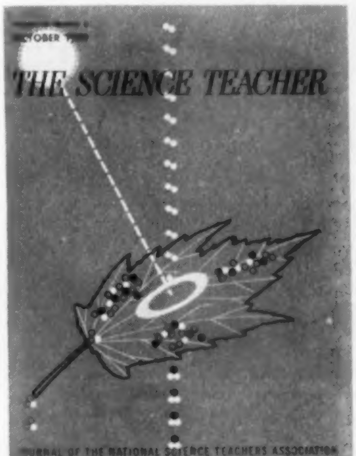
* Physical Science Study Committee.

Attention! Another Star '60 Program Award

The STAR '60 program committee announces that this year's awards (in addition to those listed on inside front cover) will be augmented by another prize which has been donated by the Bausch and Lomb Optical Company.

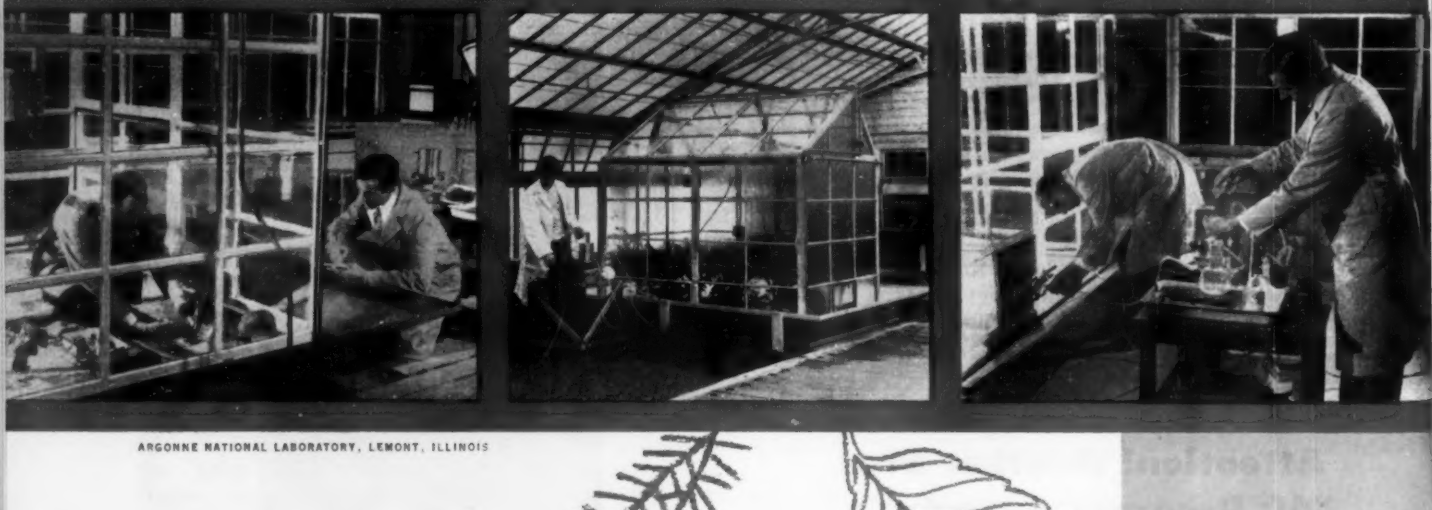
The additional award will be a new standard teaching microscope. It will be presented to one of the STAR '60 winners who will be selected by the judges of the STAR program on the basis of ingenuity and practicability in the application of microscopic techniques in teaching in his prize-winning entry.

Don't delay! All entries for the STAR Awards Program must be postmarked not later than December 15, 1959.



THIS MONTH'S COVER . . . The application of new methods to study one of science's most baffling mysteries—photosynthesis—is the subject of the lead article of the month. Photosynthesis is the process by which plants use the energy of sunlight to turn water and carbon dioxide into life's building blocks: sugar, fats, starches, and protein. Leaves of various plants have been used for these experiments, but largely those with single-celled green algae, either *Chlorella* or *Scenesdesmus*. New techniques and tracer methods used in these experiments are described on page 391.

PHOTOSYN



ARGONNE NATIONAL LABORATORY, LEMONT, ILLINOIS

Plant physiologists work in airtight nutriculture chambers to study the effects of radioactive carbon dioxide on plant growth processes. Technician George Kostel (l. and center) and Dr. Norbert J. Scully (r.).

In the center, plants are being supplied with water, nutrient materials, and radioactive carbon dioxide. The products formed as a result of photosynthesis are then more readily tagged.

Outside the chamber radioactive carbon dioxide is prepared in a flask, then pumped into the chamber where the growing plants will "breathe" and assimilate it.

YNTHESIS

By GLEN W. WATSON

University of California Radiation Laboratory, Berkeley

WHAT is the greatest reserve of energy in our world? Is it coal, oil, water, wind, uranium? It is none of these. What is the greatest source of food in the world? Is it beef, dairy products, mutton, fish? It is none of these. The answer to both questions—green plants, and surprisingly enough, probably 90 per cent of these plants are in the oceans and seas of the world.

Chemically speaking, green plants are the only productive portion of the earth's population. The term "parasite" is usually reserved for such organisms as mistletoe, dodder, lice, fleas, and tapeworms, but actually all living things except green plants are parasites in the sense that they take more than they give of the "usable" energy of this world. Green plants alone are self-sufficient. All other forms of life live on them, at least indirectly.

The process whereby green plants with the aid of the chlorophyll they contain use sunlight to grow and thus "fix" both food and energy is known as *photosynthesis*, literally a putting together by light.

Without photosynthesis, nature's most important biological process, life is not possible.

NOTE: Currently, the author is head of the Chemistry Department of Santa Rosa Junior College, California. In addition, he works on special projects at the Radiation Laboratory.

It is estimated that the annual turnover is 3×10^{11} tons of organic carbon and 3×10^{21} calories of energy. This is about 100 times the total output of mining, chemical, and metallurgical industries, and 10,000 times the energy utilized from falling water.

How far has man been able to probe or even reproduce this fundamental process? Even—or perhaps I should say *especially*—among experts there is disagreement on the correct answer to this question. One of the leaders in present-day research on photosynthesis said recently: "It is now possible to trace the entire path of carbon reduction from the entry of carbon dioxide into the plant cell to the formation of sugars and other products." An equally energetic worker and prolific writer had said at about the same time: "The path by which photosynthesis proceeds from phosphoglyceric acid (PGA) to sugar is soon lost in the mists."

It is refreshing and stimulating to turn from these expressions of judgment to relations of facts as revealed in descriptions of the original experiments. Joseph Priestley, the discoverer of oxygen, wrote in 1772, "I have been so happy as by accident to hit upon a method of restoring air which has been injured by burning of candles,

and to have discovered at least one of the restoratives which nature employs for this service. It is vegetation. One might have imagined that since common air is necessary to vegetable as well as animal life, both plants and animals had affected it in the same manner, and I own that I had that expectation when I put a sprig of mint into a glass jar standing inverted in a vessel of water, but when it had continued growing for some three months, I found that the air would neither extinguish a candle, nor was it at all inconvenient to a mouse put into it.

"Finding that candles would burn very well in air in which plants had grown for a long time—I thought it was possible that plants might also restore the air which had been injured by the burning of candles. Accordingly on the 17th of August 1771, I put a sprig of mint into a quantity of air in which a candle had burnt out and found that on the 27th of the same month another candle burned perfectly well in it."

Because Priestley was hampered by belief in the phlogiston theory he did not properly interpret the results of his experiment, but we know he observed that carbon dioxide plus growing plants releases oxygen.

The next man to *publish* important work on our topic was a Dutch physician, Jan Ingen-Housz. He had successfully inoculated against smallpox the children of Maria Theresa, Queen of Austria, and as a result enjoyed a pension which gave him independence to experiment. In June of 1779 he took a small villa in the English countryside and there working "from morning till night" performed more than 500 experiments in less than three months and reported them that October. His own words show best the extent and acuteness of his observations.

"I observed that plants not only have the faculty to correct bad air in 6 or 7 days by growing in it, but that they perform this in a few hours [we know now that much is done in less than a minute]; that this wonderful operation is by no means owing to the growth of the plant, but to the influence of the light of the sun upon the plant; that this office is performed not by the whole plant, but only by the leaves and the green stalks, and mostly by the underside of the leaves. The sun by itself has no power to mend the air without the concurrence of plants."

In 1782 Jean Senebier of Geneva published a three-volume discussion about experiments similar to Ingen-Housz's, but showed definitely the need for "fixed air" (carbon dioxide). When Lavoisier's careful weighing experiments on the ingredients and products of combustion overthrew the phlogiston theory, Ingen-Housz was quick to adopt the new theory, but had some doubts about the source of the fixed air.

There has been wide variation in published analyses of the percentage of carbon dioxide in the air. Lavoisier found none. Von Humboldt reported 0.7 to 1.4 per cent. It is now generally agreed that the average for open country is around 0.03 per cent. It is little realized by non-scientists even today that large-growing redwood trees and quick-growing corn and sugar cane, not to mention marine plankton which feed fish which feed man, all alike get their carbon from this less-than-one-part-in-three-thousand constituent of the air.

Around 1600 a Belgian physician, Jan Van Helmont, convinced himself that "wood" was nothing but water. He did this by drying and carefully weighing some soil. He planted a willow sapling in it and five years later carefully re-weighed the soil and the tree. The soil had lost only 2 ounces and the tree had gained 164 pounds. He had added only water, and therefore came to his seemingly reasonable conclusion.

In 1804 de Saussure, another Geneva scholar, repeated a similar experiment, but this time he was careful to weigh also the carbon dioxide taken in and the oxygen liberated. He found that the weight gained by the plant was greater than the difference of the above two items and that although wood is not *all* water it is *partly* water. Indeed, it has since been shown that all the oxygen released comes from the water.

Robert Mayer, a German physician who in 1842 enunciated the principle of conservation of energy, clearly stated in 1845 that plants in burning or decaying "gave back" some of the energy that had been stored in them. Thus the full photosynthetic process can be indicated by the following equation:

$$\text{Carbon dioxide} + \text{Water} + \text{radiant energy in sunlight} \xrightarrow[\text{(catalyzed by growing plants)}]{\text{gives}} \text{Organic matter} + \text{Oxygen} + \text{Potential energy of chemical constitution.}$$

Work since 1845 has been in the nature of elaboration of the details of this scheme.

No one has succeeded in observing complete photosynthesis except where there is chlorophyll present in a living plant. The constitution of

chlorophyll was sufficiently difficult so that its elucidation required several decades of work by many investigators. Two of these have been awarded the Nobel Prize as a result of their work, namely, R. Willstätter (1915) and Hans Fischer (1930).

Early suspicions that the green extracts from plants contained more than one substance were confirmed by fluorescent studies in 1864. Chromatographic methods introduced by Michael Tswett in 1906 made separation relatively easy. The two parts of chlorophyll, "a" and "b," differ in molecular weight by only 14; in chlorophyll "b" an atom of oxygen (atomic weight 16) replaces two hydrogen atoms (atomic weight 1 each). Chlorophyll is closely related to hemoglobin, the metallic part of chlorophyll being magnesium instead of iron. Recent studies indicate that hemoglobin's physical form may be as important as its chemical constitution.

In 1843 Liebig suggested that one of the "partway houses" on the road from carbon dioxide to sugars was organic acids. This seemed plausible for two reasons. The ratio of hydrogen to oxygen (the degree of reduction) in organic acids is intermediate between carbon dioxide (none) and sugars $(C\ H_2O)_x$; and, as is well known, ripening fruit is sour (acids) before it is sweet (sugars). One of Liebig's students, Baeyer (of aspirin fame), suggested rather that formaldehyde was formed first, then polymerized. Similarity of formulas for formaldehyde $(C\ H_2O)$ and for both glucose and fructose $(C\ H_2O)_6$ makes this theory attractive, and it is actually possible to make a sugarlike substance, formose, from formaldehyde *in vitro* (in test tubes). However, both classical and modern "labeled-atom" methods of analysis have failed to confirm a formaldehyde intermediate.

Tracer Chemistry

Among the new methods that have been used to investigate the problem further is tracer chemistry. The discovery of artificial radioactivity by the Joliot-Curies in 1934 started a long train of work. The number of artificially radioactive elements was greatly increased by bombardment, at first with natural radiations, later with radiations from cyclotrons, and then reactors. In general, these radionuclides behave like the common naturally occurring elements, but they can be located and counted in exceedingly small concentrations (even as individual atoms) by means of their radioactivity. (That is, they decompose

spontaneously and give off radiations such as alpha, beta, or gamma rays, which can be detected with Geiger counters, ionization chambers, electroscopes, and similar devices.)

A second new tool was a combination of ion exchange and paper chromatography. Tswett first used chromatography about 1900 to separate the green and yellow dyes in leaf extracts. He wrote in a then obscure Russian journal, and for years the method lay dormant, but starting about 1931 it had a great revival and extension.

The application of these methods to the study of photosynthesis led to many new findings. The first tracer methods were used at the University of California, because it had a cyclotron that provided labeled carbon. It was in the form of carbon 11, however, which has a half life of only 22 minutes, and this meant that only rapid methods could be used. The early products of carbon assimilation were not identified; it was shown only that they contained carboxy (COOH) and hydroxyl (OH) groups. The first piles or reactors at Oak Ridge National Laboratory and Hanford (Atomic Energy Commission) provided another radioisotope of carbon, C^{14}. This has a half life of around 5000 years, so that the duration of experiments is determined by the life of the investigator rather than that of the tracer.

New Techniques

The general idea of the experiment is easy to understand; the difficulties and ramifications appeared only later. In the first experiments a "steady state" of photosynthesis with ordinary carbon dioxide was set up. Leaves of various plants have been used, but most experiments have been done with single-celled green algae, either *Chlorella* or *Scenedesmus*. At a given time the ordinary carbon in the environment is replaced by labeled carbon either in the form of gaseous carbon dioxide, CO_2, or a solution of bicarbonate ion, HCO_3. Plant action is allowed to proceed for a measured time and then all activity is stopped (usually by plunging the plant into boiling alcohol). The problem now is to identify the chemical compounds that contain the labeled carbon. Progress by classical methods was very slow, but great strides were made possible by the new techniques. The concentrated, purified water extract is divided into several portions. The *total* radioactivity of the extract is determined by means of the well-known Geiger-Müller counter. A part of the extract is chromatogramed, as follows.

A "spot" of the extract is put near one corner of a large sheet of filter paper (18 by 22 inches). The top edge of the paper (near the spot) is dipped in a trough of development liquid (72% phenol + 28% distilled water) with the rest of the sheet hanging down over the edge, and the whole is enclosed in a box to insure even temperatures and absence of convection currents. The liquid gradually spreads through the paper

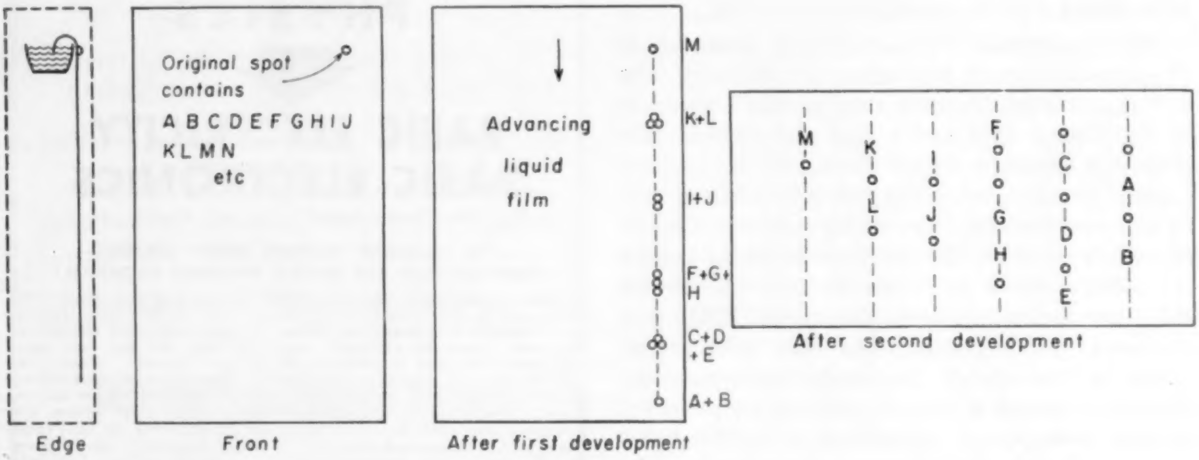
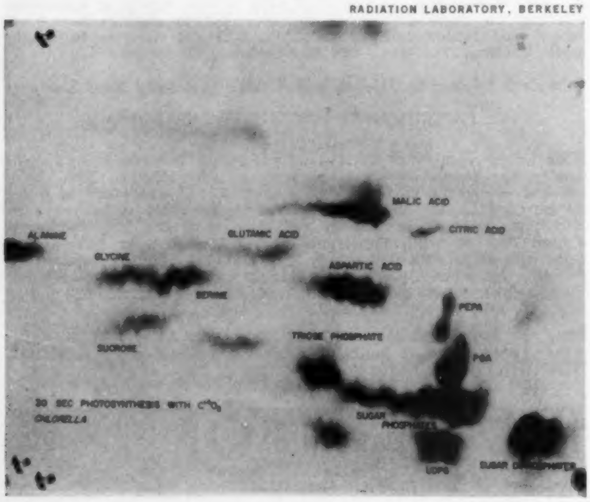


FIGURE 1

by capillary action. It takes the soluble chemical compounds along with it, but *at different rates*, so that they are spread out in a line. However, some of them may proceed at the same rate, so that only a partial separation is achieved. When the advancing wetting front reaches the other edge (bottom) of the paper, the paper is taken out and dried. Then it is turned through 90° and the process is repeated with a different solvent (normal butanol + water + propionic acid). This second "development" separates those compounds that were not separated the first time. (See Figure 1.) An example (Figure 2) shows the pattern obtained for an extract of *Chlorella* that had been allowed to photosynthesize in the presence of labeled carbon compounds for half a minute.

FIGURE 2

RADIATION LABORATORY, BERKELEY



The spots are undetectable to the ordinary senses. A general idea of variation of activity can be obtained by "scanning" with a Geiger counter, but a better method is to place a sensitized photographic plate over the sheet and leave it there for an appropriate time (about 24 hours). After development in the usual manner it shows black spots corresponding to the location of the location of the active carbon; the greater the activity at that position the blacker the spot. This whole process of two-dimensional chromatography followed by radioautography permits the sorting out of confusingly complex products of photosynthesis.

Identifying the chemical nature of the spots still constituted a major problem, but was eventually solved by comparison with the behavior of known substances.

These methods established the fact that one of the first substances formed in photosynthesis is phosphoglyceric acid (PGA), whose formula is

```
O=C*—OH
  |
H—C—OH OH
  |    |
H—C—O—P=O
  |    |
  H    OH
```

Most of the radioactivity is on the carboxyl carbon (marked with an asterisk). Unraveling the steps by which the carbon goes from there to sucrose turned out to be exciting but extraordinarily difficult. One reason is that the plants not only make sugar but also live, themselves, and no completely satisfactory method has been found to differentiate between the products of their own respiration and some of the steps in photosynthesis. One example is that labeled carbon appears very early in malic acid, alanine, and aspartic acid (30 seconds), yet these almost certainly are not steps in photosynthesis.

If a "steady state" is established while the plants are using radioactive carbon and the light is then turned off, it is found that the concentrations of some compounds increase and others decrease. This has helped to establish the order of some steps in a possible cycle. A more detailed account of this work is found in *The Path of Carbon in Photosynthesis,* by J. A. Bassham and Melvin Calvin (Prentice-Hall, New York, 1957).

Role of Chlorophyll

Although no one has seen photosynthesis outside a living cell, two of the contributing steps have been done separately. In 1937, R. Hill found that ground-up green leaves plus ferric potassium oxalate would release molecular oxygen—this is one part of the photosynthetic reaction. In 1948, A. A. Kraznowsky found that chlorophyll would catalyze the reduction of quinone by ascorbic acid; a definite intermediate compound of chlorophyll (pink) was formed. In other words, chlorophyll could "steal" hydrogen from one compound and "give" it to another. That is what it does in photosynthesis; it takes hydrogen from water and gives it to carbon dioxide.

Much recent work has been done on the anatomy of chlorophyll in its natural surroundings (the only place where it promotes photosynthesis). Chlorophyll is located in almost all plants in the so-called chloroplasts, small green bodies within the cells. Descriptions of these have varied as much as reports of flying saucers, but now that electron microscopes have sharpened the eyes of the investigators there is general agreement. Inside the chloroplasts are smaller particles called grana. Each of these is shaped like a snare drum and can be broken into further thin sheets like a stack of plates. It is thought that these platelets are made up of protein molecules and are originally held together by fatlike substances (in a twenty-decker sandwich).

When discussing the hemoglobin molecule we said "its physical form may be as important as its chemical constitution." Maybe the shape of the chlorophyll molecule, also, is important. It is well known that soaps and detergents owe their cleaning power to the fact that their individual molecules are shaped somewhat like tadpoles. Each molecule has an inorganic "head," soluble in water, and an organic "tail," soluble in fats. When present at an interface they line up one layer thick, tails to the center, like a herd of cattle protecting themselves from a pack of wolves. This emulsifies the fat (i.e., walls the fat droplets off from one another), agitation forces the dirt to drop off, and the clothes become clean.

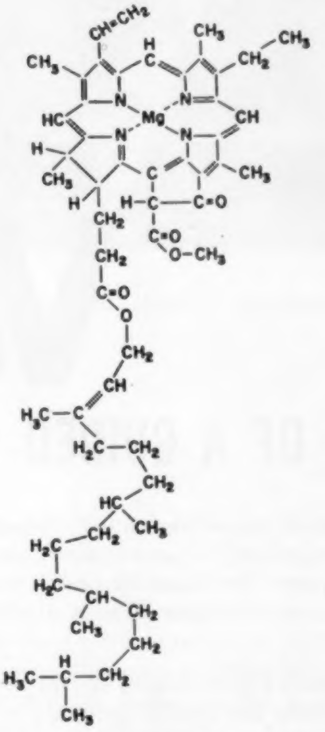
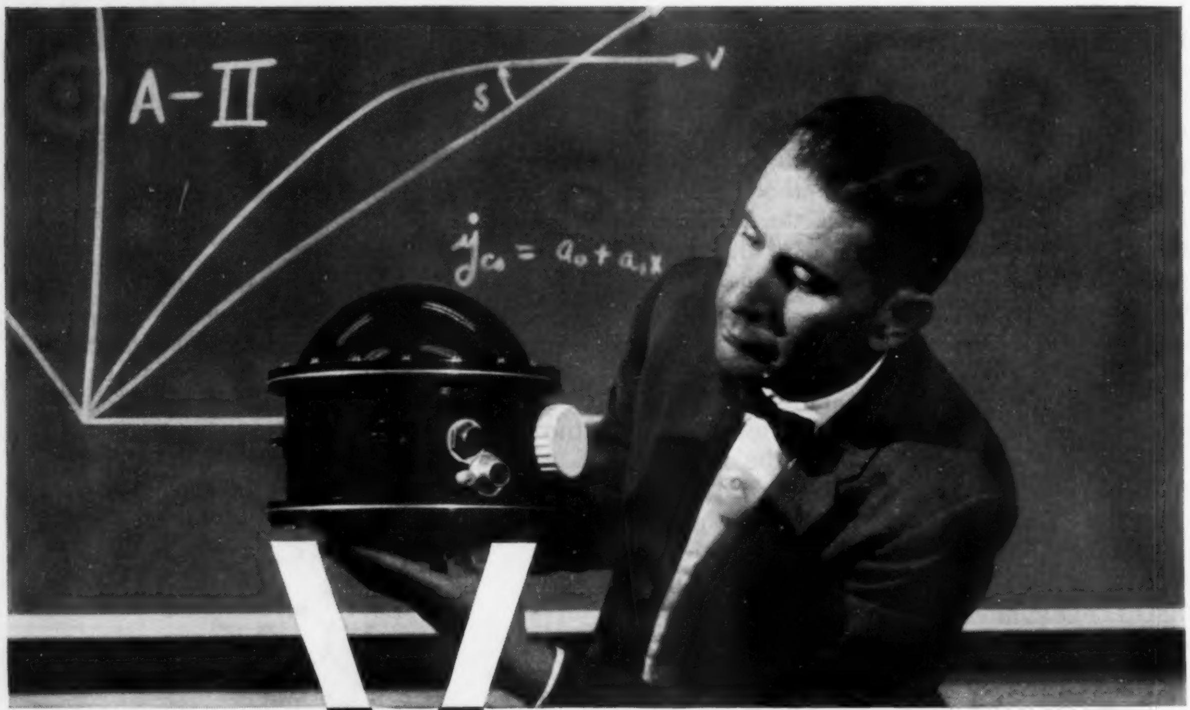


FIGURE 3

Calculation of weights, molecular sizes, and areas shows that there is just about enough chlorophyll in a chloroplast to fit in between the slices of the grana. Furthermore the chlorophyll molecule has a green water-loving (hydrophyllic) (or protein-loving) head and a colorless fat-loving (lypophyllic) tail (Figure 3). So maybe the chlorophyll molecule is effective because it nestles snugly into the sandwich with its head in the bread and its tail in the butter, and helps to keep all the ingredients from falling apart.



Edwin Felch, project director in charge of developing the Titan guidance system, holds the "voice" of the ICBM.

VOICE OF A GUIDED MISSILE

This is a missile-borne transmitter. It is the "voice" of a missile in flight . . . part of a new radio-inertial guidance system developed by Bell Telephone Laboratories for the Ballistic Missile Division of the Air Force.

This versatile system helped deliver the nose cone of a Thor-Able test missile precisely to its South Atlantic target area—5000 miles from Cape Canaveral, Florida. So accurately was the nose cone placed that a waiting group of ships and planes retrieved it in a matter of hours. It was the first nose cone ever to be recovered after so long a flight.

The command guidance system which made such accuracy possible combines precision tracking radar with a special Remington Rand Univac computer. Fed a steady stream of signals from the missile-borne transmitter, the ground-based equipment compares the missile's flight path with the preselected path. Corrective steering orders are computed and transmitted automatically to the missile. The ground station monitors the progress of the flight continuously and obtains immediate evaluation of mission success. And since the principal control equipment is kept on the ground, expendable hardware in the missile itself is minimized.

This radio-inertial guidance system is a product of the Bell Laboratories-Western Electric development-production team. It is in production at Western Electric for the first operational squadrons of the Titan intercontinental ballistic missile.

Bell Labs scientists and engineers developed the world's most versatile telephone network and much of our nation's radar. They have constantly pioneered in missile systems. From their storehouse of knowledge and experience comes this new achievement in missile guidance.

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COLLEGE ACTIONS

PURCELL PHOTO, NEA

A Report on CEEB Advanced Placement Mathematics and Natural Sciences Examinations Candidates, May 1958

By JOHN R. VALLEY

CEEB Program Director, Educational Testing Service, Princeton, New Jersey

THE College Entrance Examination Board Advanced Placement Program, which encourages the offering by secondary schools of special advanced courses for able students and the recognition by colleges of the special attainment of these students, includes examinations in mathematics, biology, chemistry, and physics. While the total number of students participating in the program in all areas is modest, it is steadily growing. In 1956, the first year of the program under CEEB sponsorship, 104 schools sent 1229 candidates who took 2199 tests. Last year 355 schools sent 3715 candidates to take 6800 examinations. Of the 6800 examinations administered, about 1/3 were in the natural sciences of biology, physics, chemistry, and in mathematics. Table I shows a distribution of candidates by examination area.

Information is now available as to the actions taken by colleges when these students matriculated as freshmen in the fall of 1958. A questionnaire requesting information as to the actions taken accompanied each candidate's examination scores to the college. Colleges completed the questionnaire and returned one copy directly to the secondary school at which the candidate prepared. The original was returned to Educational Testing Service. The material that follows reports on the tabulations made of the questionnaires returned to ETS.[1]

TABLE I

Number of Advanced Placement Examination Candidates

Test	1956	1957	1958
Biology	86	148	212
Chemistry	189	269	476
Physics	102	219	368
Mathematics	386	724	1178
Total Sciences and Mathematics	763	1360	2234
All Examinations	2199	3772	6800

[1] Dr. Marjorie Olsen, ETS Statistical Analysis Division, was responsible for the tabulations of the data cited in this report.

In comparing the college actions in each of the sciences with the actions of the colleges in the program generally, it can be seen in Table II that the candidates in biology and chemistry fared about as well as did candidates generally. Mathematics candidates tended to be recognized more frequently and physics candidates less frequently by colleges granting advanced placement, credit, or both. Some factors which contribute to these differences are discussed later.

There appears to be a relationship between the number of candidates which a college has and the likelihood of a candidate's receiving placement, credit, or both. Table III shows a steady progressive increase in the per cent of candidates awarded placement, credit, or both in all examinations as one moves from institutions which receive only one or relatively few candidates to colleges with substantial numbers of advanced placement candidates. Of course, the actions taken by colleges represent the outcomes of a host of factors. Yet it is reasonable to assume that those institutions which receive large numbers of candidates annually are more likely to have the administrative machinery in operation for handling the candidates. This in turn could give rise to a larger proportion of the candidates to these institutions receiving favorable consideration. It is especially interesting to observe

PHOTO BY JOHN NELSON, PHOENIX ARIZONA HIGH SCHOOL
EASTMAN KODAK COMPANY PHOTO CONTEST

Concentration and application of what has been learned are prerequisites in mastering the placement examination.

TABLE II

College Actions on Advanced Placement Examination Candidates

Subject	Number for Whom Questionnaires Were Received	Candidates Awarded Advanced Placement Credit, or Both	
		Number	Per Cent
Biology	133	60	45
Chemistry	361	163	45
Physics	261	99	38
Mathematics	996	601	60
All Examinations [2]	5508	2669	48

[2] In addition to the examinations listed in Table II, the program includes tests in French, German, Spanish, Latin, American History, European History, and English Composition and Literature.

TABLE III

College Actions by Colleges Grouped According to the Number of Candidates in All Examinations

	Per Cent Granted Advanced Placement, Credit, or Both				
Test Taken	Colleges with Less than 5 Candidates	Colleges with 5-50 Candidates	Colleges with 51-125 Candidates	Colleges with 126-350 Candidates	All Candidates
Biology	(27)	36	47	67	45
Chemistry	(48)	41	40	55	45
Physics	(15)	26	32	54	38
Mathematics	29	49	61	78	60
All Examinations	38	42	47	59	48
Number of Colleges	113	78	10	3	204

(Per cents based on fewer than 25 students are enclosed in parentheses.)

that in the three largest institutions the physics candidates pretty well overcome the forces which limit their chances for placement or credit in colleges generally. Note 54 per cent of physics candidates in the largest institutions were placed or given credit and 38 per cent of physics candidates were so recognized at all colleges.

TABLE IV

Average Grades of Candidates Awarded and Not Awarded Placement or Credit

Test	Awarded Credit, Placement or Both Mean Grade	Not Awarded Credit or Placement Mean Grade
Biology	3.50	2.45
Chemistry	3.69	2.48
Physics	3.72	2.44
Mathematics	3.48	1.88
All Examinations	3.44	2.39

When tabulations of college actions by grade level on the examinations are studied, one can draw the following conclusions:

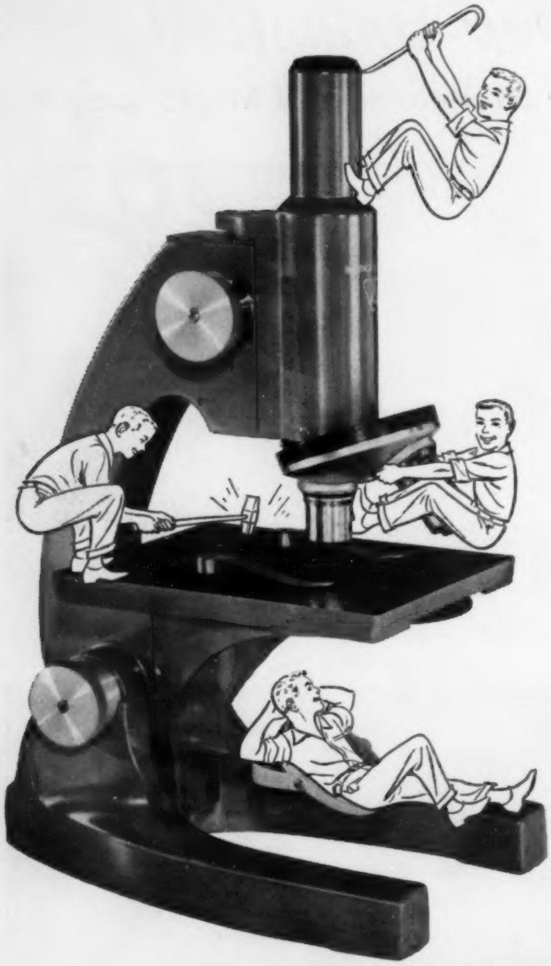
1. A candidate who fails the test has little chance for placement or credit.
2. The odds are still against the candidate when he earns a grade of 2.
3. A candidate has about an even chance with a grade of 3.
4. The odds range from very favorable to virtual certainty of placement, credit, or both with grades of 4 and 5.

As would be expected, candidate performance on the examinations is an important determiner of the actions taken by colleges. In the program generally there is slightly more than a full grade-level difference on the average between those candidates receiving credit and placement and those who did not. The average grades for the two groups were 3.44 and 2.39, respectively, on a scale in which the grade of 5 signifies high honors, 4 honors, 3 creditable, 2 pass, 1 fail. Table IV shows the average grades for each science test for those awarded and those not awarded credit or placement. In biology, chemistry, and physics the differential between the two groups was just about the same as it was in the program generally or just slightly greater. However, in mathematics the differential between the two groups exceeded a grade level and a half (1.60). It is encouraging to note that this was not due to colleges' setting a standard for placement and credit in mathematics which was higher than that found in other areas. It was due largely to the fact that relatively few high-scoring candidates in mathematics were denied credit, placement, or both.

The proceeding statements should not be interpreted as minimizing considerations other than the examination grades in determining the actions of colleges. The opportunity was provided for colleges to report the reasons for their actions on individual candidates. Since the college had the opportunity to check several reasons for its actions as well as to comment on the reverse side of the form, these responses do not lend themselves readily to summarizations. However, some observations can be made.

1. Failure to apply for credit or placement was the reason cited for students not receiving consideration in 77 cases in the four examinations under discussion in this report. Teachers of students in advanced courses might do well to urge their students to determine what the procedures are at particular colleges since there is evidence that in some instances the college expects the student to take the initiative by formally requesting consideration.
2. Apparently most colleges found the examination itself to be adequate and to provide the information the college needs in order to grant placement, credit, or both. There were only 14 colleges that cited the inadequacy of the examinations as a reason for granting neither placement nor credit in mathematics, biology, chemistry, or physics.
3. In some instances the college was unable to grant placement or credit because the course which the student completed, while considered satisfactory, did not parallel sufficiently the courses taught at the college. This matter has proven to be a problem in a limited num- of institutions.

In summary, the growth in the number of Advanced Placement Examination candidates in the natural sciences and mathematics has reasonably paralleled the growth in the program generally. Candidates in the examinations discussed in this paper were in general granted placement and credit as frequently as candidates in all examinations, although there were differences from one area to another with physics candidates faring less well and mathematics candidates faring better. While many factors apparently influenced the college's decision regarding placement and credit, the odds were about even that a candidate would receive placement, credit, or both if he had a grade of 3. If the candidate had a grade of 4 or 5, it was the exception if placement, credit, or both were not granted.



Readiness in Problem Solving

By MAURICE BLEIFELD

Principal, Benjamin Franklin High School, New York City

From a talk presented at the Winter Conference of the Science Teachers Association of New York State, New York City, January 23, 1959.

MUCH has been said and written about the ways in which science teaching differs from teaching in other fields such as English, a foreign language, and other subjects. It is generally agreed also that one of the most unique features of science teaching is the opportunity it affords to develop in others scientific attitudes and scientific methods in solving problems.

The study of science, we are told, brings home to students the importance of suspending judgment until they have sufficient data to reach a conclusion. By remaining open-minded, the student is willing to change his beliefs when new evidence is presented. This in turn points to the development of critical-mindedness in evaluating the facts and opinions he collects. There is emphasis on patience in accumulating information, and meticulous accuracy in recording the data; on repeating experiments for the purpose of verification; on the habit of intellectual honesty; on respect for the accomplishments of scientists regardless of their national origin; and on cooperation among scientists in seeking the truth through exchange of ideas.

The vital question that faces (or should face) science teachers is: How is the student best helped to acquire these qualities of thought, procedure, and action? Surely, not by the memorization of facts alone, which in themselves may be considered as tools for understanding the world about him, or of interpreting what he learns. Instead, the student can acquire the habit of scientific attitude and method by practicing and being part of situations in which there is opportunity to experience, firsthand, the different elements of problem-solving procedures.

It is probably safe to say that most students who are beginning high school science have had but limited experience with this approach. They have not been much involved in extensive, thought-provoking activities. Instead, they have been accustomed to teacher-centered situations where the chief thought and activities were directed from the teacher to the pupils—rarely from the pupils to the pupils, or from the pupils to the teacher. They have rarely been called on to evaluate critically or to derive opinions based on factual evidence.

As a result, most pupils are noncritical; they are ready to accept at face value whatever the teacher presents, without participating in the formulation of what is presented. In a sense, the teaching, even of science, may be said to have been unscientific, from this point of view.

With this background of the students' status in mind, the science teacher who is interested and eager to use the problem-solving approach must first proceed to create a state of readiness for the

A Class Exercise is begun by the author (center) to establish readiness for problem solving.

year's work. To leap directly into problem-solving situations might otherwise prove to be frustrating, because the pupils are not prepared for the role they are to play and because they may not understand what is expected of them. Two approaches to creating this readiness for problem solving are considered here; namely, through a class exercise, and the classroom atmosphere.

Readiness Through a Class Exercise

An exercise such as the following[1] might be used very early in the term. As the class enters the room, they notice four setups on the demonstration table, each labeled with a question:

1. A battery jar of water in which a goldfish is floating on its side; there are two wires in the water, leading to a dry cell. The card bears the question: "What do you see? What is your explanation?"
2. Four newspaper photographs of men wearing business suits. The question: "Who is the Congressman, A, B, C, or D?"
3. Two identical blocks of wood, labeled A and B. The question, "Which is heavier, A or B? Or do they weigh the same?"
4. Two beakers of colorless liquid. Question: "What color will result when the two liquids are mixed?"

The pupils are instructed to answer these questions quickly in their notebooks. After a brief period of time, in which they are permitted to come to the desk to observe the demonstrations more closely, but without handling them or discussing them with anyone, the teacher calls on them for their results. He records the number of pupils who agree with the answers which, in most cases, are as follows:

1. The fish is dead; it was electrocuted.
2. The votes for A, B, C, and D may vary, depending on the appearance of the men.
3. The two blocks weigh the same.
4. The mixed liquids will continue to be colorless.

Then the answers are discussed. The pupils are asked to give reasons for their answers. Early in the discussion of question 4, it will undoubtedly be suggested that the two liquids be mixed. A pupil may be called up to do this. The appearance of a purple color usually proves to be startling. The curiosity of the class can be answered briefly with the explanation that one beaker contained slightly acidified water with some phenolphthalein, and the other, diluted sodium hydroxide solution. The demonstration can be repeated. Then, referring to the earlier answer of the class, the teacher can elicit the statement that the class could not really answer the question until it knew what was in the two beakers and what occurs when the liquids are mixed. In other words, there was insufficient evidence for the answer given by most students.

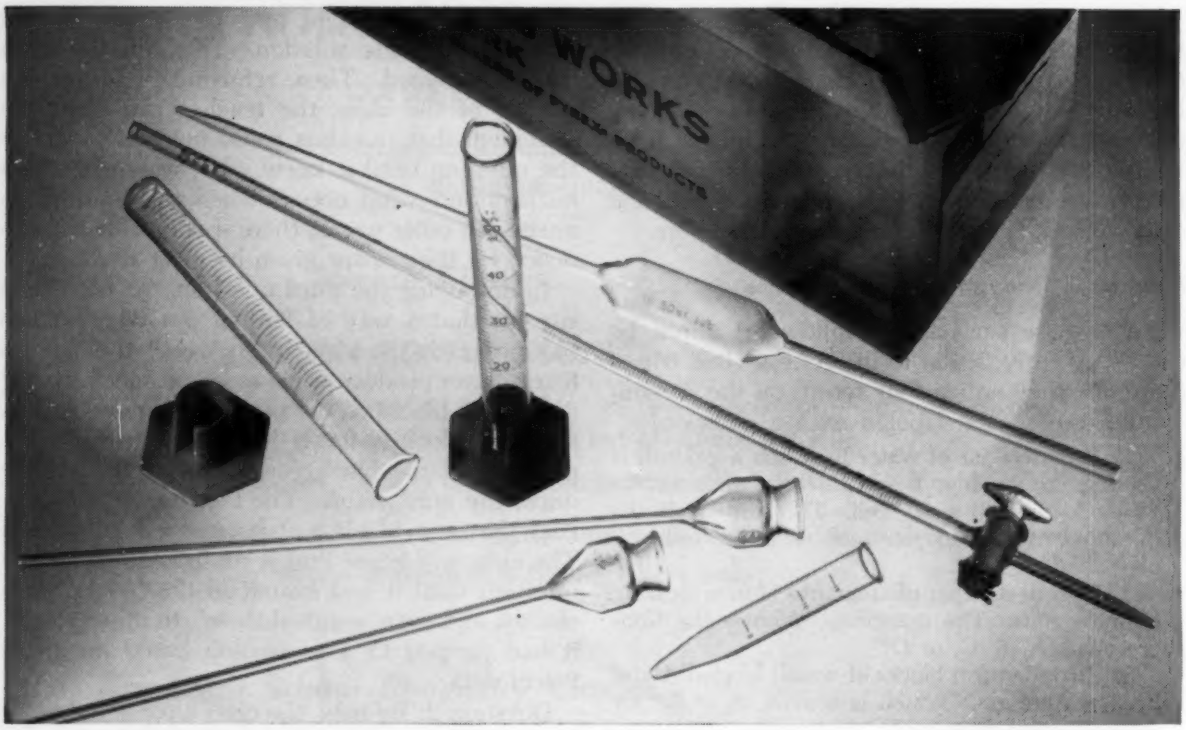
In discussing the third question, the class may suggest that a way of finding out whether the blocks weigh the same is to weigh them. The teacher can produce a balance and have a pupil place both blocks on the pans. It can now be seen that one block is much heavier. Reversing the positions of the block (and why do this?) produces the same result. The teacher can then reveal that one block had been filled with lead. The class will agree that it could not answer the question until it had examined the blocks more closely, and even weighed them. In other words, it had jumped to a conclusion based on insufficient data.

Question 2: By now, the class has undoubtedly become more cautious and may be clamoring for more information about the men in the pictures. Their names are announced by the teacher, and the occupation of each is given; they may be a government official, a professor, a businessman, a criminal, or a scientist whose names have currently been in the news. The class is now ready to admit that a person's looks do not indicate his character; also, that they did not have enough facts about the men to answer the question.

Establishing the facts by experimentation in a class exercise, and then evaluation of the results.

HOWLAND PUBLIC SCHOOL, CHICAGO, ILLINOIS

[1] Based on "Individual Laboratory Lessons in Biology: Experiment 10, Straight Thinking." Association of Teachers of Biological Sciences, New York. 1948.


WORKS

Question 1: The class is probably ready either to repudiate its first answer, although it may not know why, or to stand by the answer in the hope that this one, at least, will be correct. The teacher can have the class suggest some questions it would like to have answered. Since there is likely to be a question about the dry cell, it can be shown to be nonfunctional by testing it with a bell and showing that it does not make the bell ring. By comparison, another dry cell can be shown to ring the bell. Obviously, the dry cell could not have electrocuted the fish, but there is still a question as to what did. The teacher can now ask the pupils how they know that the fish *is* dead. They will point out that it was floating on its side and that it has not moved. The teacher may now reveal that this fish had been anaesthesized with chloretone (two or three teaspoonfuls of a saturated solution in about 125 ml of water), and that it will recover after being placed in fresh water. The class is now ready to agree that it could not answer the original question properly, since it did not have all the facts about the case.

Evaluation

After the four questions have been discussed in this manner, the teacher may ask the class how it would now answer them. In each case, the answer would be: "I don't know. I don't have enough facts to answer the question." The idea that the correct answer is "I don't know" is unusual, or startling to most pupils. Too much previous training has taught them that not to know the answers to questions will result in a penalty of some kind.

If the teacher asks for the purpose of the entire exercise, the pupils should be able to state that they must have all the facts before they can answer a question; that they have learned, in a limited way, the importance of suspending judgment, and that their opinions should be based on facts; that by being open-minded, they were able to change their minds about their answers as they observed the facts; that in addition, the scientific attitude requires critical-mindedness and patience in each experiment.

With the invitation on the part of the teacher to join him in many other problem-solving situations throughout the course, the class is more ready to plan, evaluate, and participate in lessons that can be of a truly scientific nature, whether they be discussion lessons, lessons with demonstrations, or laboratory lessons.

Another aspect of creating readiness for problem-solving participation by the students is the atmosphere generated and maintained by the teacher in the classroom. Unfortunately, most teaching is overly teacher-dominated. In the normal course of events, the teacher sets the stage for the lesson, announces the aim, directs the questioning, and assigns the homework. In addition, in a science lesson, the demonstration usually stems from the teacher's preparation, and the laboratory work from his direction or from the workbook's sequence. The laboratory exercise is frequently of the cookbook variety. If the pupil follows the steps in proper order, he will come out with a well-baked product, but he may understand little of what he has done, or why.

Readiness Through the Classroom Atmosphere

This method of teaching has the effect of relegating to the pupil a passive role. He usually participates only when called upon by the teacher to answer a question, to recite at the blackboard, to summarize, or to play a specific role in a demonstration or laboratory exercise. From habit, his chief aim seems to be to follow the path charted by the teacher; rarely is he actively encouraged to suggest other paths. In few cases is he ever asked to evaluate, to agree or disagree, to suggest how to prove a point. He hardly ever thinks through the steps in a laboratory exercise.

The teacher-dominated lesson discourages and even eliminates the problem-solving approach. The pupils are hardly given an opportunity to plan the procedures; to offer their own solutions; sometimes, even to state their own observations and to evaluate the observations of others before agreement is reached; to try out suggestions that may be incorrect, before concluding that they are not valid.

Too frequently the teacher sets himself at the center of the stage, often without realizing it, instead of creating a pupil-centered climate. He says, "Tell *me*" instead of "Tell *us*." He decides whether a pupil's answer is correct or incorrect instead of asking the pupils what they think, or whether they agree or disagree. When he displays a chart, he may describe it himself. Or, if he does call on a pupil to tell about the chart, he himself may evaluate what the pupil says, rather than having the pupil call on his classmates who are raising their hands to comment about his recitation. When a pupil is sent to the blackboard to write an answer or work out a problem, the

(Continued on page 447)

Vocational Explorations in Science

By BERNARD L. ALBERG

Science Teacher, Kaukauna High School, Kaukauna, Wisconsin

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

THE growth of the school population in the last decade has brought about any number of problems and changes. The matter of presenting occupational information to students has become much more complex with the increasing numbers in science classes and homerooms. The teacher who answered questions about various occupations as they arose, and presented new occupational information "piecemeal" found that larger numbers meant more planning, more responsibility on the classroom teacher in guidance, and a direct rather than incidental approach to the problem. The role of the guidance counselor in the school has gradually changed to that of a guidance consultant. It would seem appropriate, then, to present occupational information in science areas as a planned unit in the science course, with the guidance counselor assisting the science teacher in planning and preparing the unit.

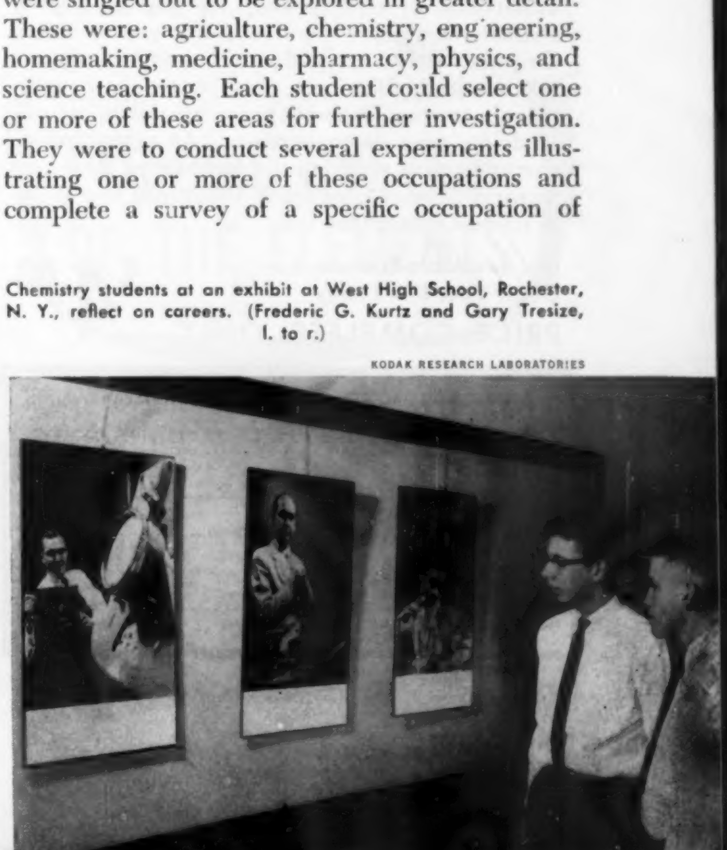
The following unit was prepared under such circumstances and has been used with satisfying results for two years in four sections of chemistry classes each year. Although the specific directions for some of the experiments have undergone a number of changes, the basic outline of the unit has remained the same. The unit was used after the "basic" part of the chemistry course had been completed. Students provided much of their own direction and used many of the laboratory techniques learned previously.

Preparation for the Unit

There are many excellent films available for use in vocational guidance in science areas. The film "Decision for Chemistry," available from Monsanto Chemical Company, was the one used to begin this unit. After discussing the film and the advantages of a knowledge of chemistry in various occupations, certain vocational areas were singled out to be explored in greater detail. These were: agriculture, chemistry, engineering, homemaking, medicine, pharmacy, physics, and science teaching. Each student could select one or more of these areas for further investigation. They were to conduct several experiments illustrating one or more of these occupations and complete a survey of a specific occupation of

Chemistry students at an exhibit at West High School, Rochester, N. Y., reflect on careers. (Frederic G. Kurtz and Gary Tresize, l. to r.)

KODAK RESEARCH LABORATORIES



their own choice. The survey used was suggested by the National Vocational Guidance Association. A mimeographed list of pamphlets, books, and articles of career information available in the classroom and the library was provided for each student.

The class was divided into small groups by their interest in the various occupational fields. If there were a large number in one group, it was divided into two or more sub-groups. Working in groups of two to five, students conducted several experiments in at least one vocational area. They provided most of their own direction with the teacher as a "consultant." Reports of their experiments, the occupational survey, and observation by the teacher served as a basis for evaluating the work. A display of the finished experiments was used for a visit by another science class, but would be suitable as a hall display, for visiting science classes, for homeroom groups studying occupations, or for adult groups.

Laboratory Activities for the Unit

The laboratory problems from which the students selected their own experiments are listed below. The detailed directions, used mainly as a

reference by the teacher, are not included here.

Vocations in Agriculture

Experiment 1. Using fresh, unpasteurized milk and rennet, duplicate the cheese-making process in the laboratory. Find a suitable place to age the cheese and check the final product for texture and quality.

*Experiment 2. Find the maximum amount that the germination time of seeds can be shortened by controlling various conditions.

Experiment 3. Devise an experiment to demonstrate the effect of rainfall in "leaching" soil minerals.

*Experiment 4. Dehydrate a common vegetable under various conditions. Attempt to restore the vegetable to its original state. Use food coloring, seasoning, or other materials. Record all variations and changes that occur.

Experiment 5. Package a perishable food in various types of materials under different conditions. Determine the best packaging material for the particular food product.

Vocations in Chemistry

Experiment 1. Beginning with the elements, synthesize magnesium carbonate, nitric acid, calcium nitrate, or some other compound suggested or approved by the teacher.

Experiment 2. Determine, by titration, the acidity or basidity of household ammonia, vinegar, fresh citrus juice, milk, baking soda, saliva, or other common substance approved by the teacher.

Experiment 3. Compare the "flashpoints" of several samples of different brands and grades of fuel oil.

Experiment 4. Prepare a color chart of as many shades of yellow as can be distinguished. Use the chart to compare various brands of butter, and rate them for marketing appeal.

Experiment 5. Qualitatively analyze a substance of complex structure and unknown composition. Use a rock, coin, alloyed metal, or other substance approved by the teacher.

Vocations in Engineering

Experiment 1. A manufacturing process involves decanting a poisonous liquid from an immiscible solution. Design a piece of equipment that will do this effectively and safely.

Experiment 2. A certain manufacturing company does considerable testing of the product in their laboratory. In this process, single test tubes must be successively heated and cooled. Devise and test a piece of equipment that will do this effectively.

Experiment 3. Graph the solubility of some common salt against temperature.

Experiment 4. Determine the temperature at which some common chemical reaction will be the most efficient.

Experiment 5. In this experiment the situation is an industrial process in which containers are filled to a certain level with a liquid. Due to human error, employees occasionally allow the containers to overflow. Originate and demonstrate a working model of a device that will automatically change the container when it reaches the proper level, regardless of the rate of flow.

* Experiments adapted from a Report of the 1956 West Coast Science Teachers Summer Conference, *The Science Teacher*, 23:337-52. November 1956.

Experiments in Homemaking

Experiment 1. Prepare and identify the odor of amyl acetate, ethyl butyrate, ethyl acetate, and methyl salicylate.

Experiment 2. Prepare pectin and use it to make jelly. Use commercial pectin to make another batch of jelly and compare the results.

Experiment 3. Compare the carbon dioxide content of various brands of commercial baking powder. Note the speed with which the carbon dioxide is released in each sample.

Experiment 4. Prepare cream of tartar from grape juice. Compare your preparation with a commercial preparation.

Experiment 5. Prepare samples of mordanted and unmordanted cloth of various materials to use in testing different dyes. Note the types of cloth that "take" best with each color and type of cloth.

Vocations in Medicine

Experiment 1. Testing for anemia. Test several of your classmates for anemia.

Experiment 2. Experiment in blood-typing. Determine the blood type of several of your classmates.

Experiment 3. Growing cultures. Prepare sterile, nutrient solutions in Petri dishes. Keep one as a control, and expose the others to possible sources of bacteria, such as: the air in different rooms in school, door knobs, fingernail scrapings, saliva, lips, or others. The experiment may be continued by testing various brands of mouthwash or other antiseptics on the cultures.

Experiment 4. Charting temperature and pulse rates. Chart the temperature and pulse rates of one or more of your classmates, introducing as many variations of circumstances as possible.

Experiment 5. Determination of the pH of saliva. Check the pH of yourself or one of your classmates. Variations may occur after eating certain foods or because of other conditions.

Vocations in Pharmacy. Obtain actual prescriptions from your druggist for the following items and prepare them in the school laboratory.

Experiment 1. Prepare white lotion.

Experiment 2. Prepare calamine lotion.

Experiment 3. Prepare liquid petrolatum.

Experiment 4. Weigh and fill capsules (lactose used as the filler).

Experiment 5. Prepare corn remover.

Vocations in Physics

Experiment 1. Measuring the rate-of-flow of water. Devise and construct a meter to measure the rate-of-flow of water through laboratory tubing.

Experiment 2. Thermostatically controlled appliance. Construct a thermostat and connect it in an electrical circuit with a fan or an electrical heating device.

Experiment 3. Relay switch. Illustrate a relay switch by using a small, battery-powered circuit to open and close a 110-volt circuit which, in turn, will operate some appliance.

Experiment 4. The three-way switch. Using flashlight batteries and bulb, construct and demonstrate a three-way switch.

Experiment 5. Lever systems. Construct a system of levers whereby a horizontal pushing force, through a long distance will raise a resistance and bring it forward a relatively short distance. Find and demonstrate a practical application of this lever system.

Vocations in Science Teaching

Experiment 1. Demonstration experiments. Conduct a demonstration experiment before a junior high school science class. Make the necessary arrangements with the teacher. List the points you wish to illustrate in the demonstration and test the students on these points.

Experiment 2. The use of teaching aids. Arrange with a junior high science teacher to show a film or filmstrip to the class. Properly introduce the visual material and use other appropriate teaching and testing procedures.

Experiment 3. Giving directions. Arrange with the general science teacher to give directions for the next individual experiment. Assuming that any errors are the result of improper directions, check the results to determine the effectiveness of the instruction.

Experiment 4. Field trips. Arrange with an elementary science teacher to make preparations for, teacher approve all phases of your planning and accompany the field trip.

Experiment 5. Teaching aids. Arrange a bulletin board display and construct some other teaching aid, such as a chart, model, or object to use in a particular unit in a science class.

In conclusion, the unit illustrating vocations in science areas has proved to be of greater-than-usual interest to the students. From the standpoint of the teacher it has helped fill the need for more vocational guidance and, at the same time, provided an opportunity for students to work independently on projects of their own selection. One of the more important results of the unit was the number of questions about vocations raised by students during the informal class periods in the laboratory.


parallel-series

The Elementary School Science REPORTER

Workshops in Elementary School Science

By HAROLD E. TANNENBAUM

Professor of Science Education, State University College of Education, New Paltz, New York

EDITOR'S NOTE: Beginning with this issue of TST, a series of articles on various programs in elementary school science throughout the country will be reported. Mr. Tannenbaum, who will be responsible for the series, will welcome suggestions from science teachers and supervisors on any phase of elementary school science. Write him at the above address.

With the rising interest in science curricula, community after community and state after state have been taking a new look at their elementary school science programs. Within the past two or three years, groups of teachers have been meeting for two- or three-week workshops to do some or all of the following things: (a) To re-examine the existing programs in elementary school science; (b) To establish objectives for teaching science in today's elementary schools; (c) To establish criteria for the selection of the science materials to be taught; (d) To choose the materials to be taught; (e) To determine ways of making this material clear, first of all to the teachers themselves, and then to the children.

It is the last step that makes the current investigations somewhat different from what was done in the past. The teachers in the workshops today are actually digging into the science materials: trying out ways of teaching electricity to children; finding ways of making big distances, or great periods of time, or microscopic sizes real and concrete for children. The workshop idea is certainly not a new one. But, in recent years, it has been distorted. Any college course of less than a semester's duration has been given the title of "workshop." The unique part about many of these current elementary school science workshops is that they have gone back to the original meaning of the term. The teachers who are participating in these workshop programs are really coming to grips with their own basic educational problems and are participating in evolving solutions to these problems.

An example of the kind of thing that is happening is the program carried on by the school system in Ossining, New York. Ossining is a small city about twenty-five miles north of New York City. The Superintendent of Schools, Dr. Charles M. Northrup, has assumed that the teachers are a professional group who can and who want to solve their own curriculum problems. One consequence has been that essentially all of the primary grade teachers were involved in a sixteen-week series of three-hour workshops in science for grades K-2. The teachers, working with a visiting science specialist, studied both the science concepts which seemed most desirable for presentation to young children and the techniques through which such concepts could be presented. The specialist provided direct experiences for the teachers and helped them find materials and experiences to use both for enriching their own backgrounds and for working with children. The workshop also used other resource people—a local doctor to talk about teaching health practices, a mother who had a thorough knowledge of the geology of the area, special agencies in the community such as the Audubon Society Preserve for Westchester County. The willingness of both individuals and agencies to

assist them with their plans and programs was a most pleasant incidental discovery.

The teachers who participated in these workshops and the elementary school supervisor are now preparing a curriculum guide which will provide selected areas in science for young children, and also detailed suggestions for exploring the science concepts involved. The teachers have emphatically stated that they do not want and cannot use a prescribed program. But they all want a recommended, generalized program along with suggested techniques which they can employ for any one of the various paths which they may choose to follow with a given class.

Another example is the Fairfax County, Virginia school system. Here, under the leadership of Assistant Superintendent W. Harold Ford, Virginia Benson, the elementary supervisor, William S. Graybeal, the secondary supervisor, and A. Neal Shedd, the science supervisor, have organized a workshop program in science for grades one through twelve. This school system is much larger and has many more teachers than the Ossining system. So, the first big difference in the two programs is that a much smaller percentage of the Fairfax teachers have been directly involved in the early stages of constructing their curriculum guide. In Ossining the primary grade teachers worked on the problem by themselves while Fairfax had a single workshop group with teachers from first grade through high school physics and chemistry all working together. The Ossining teachers argued that they wanted to concentrate on the science needs of young children. The Fairfax people said that they wanted a unified science program for the entire system.

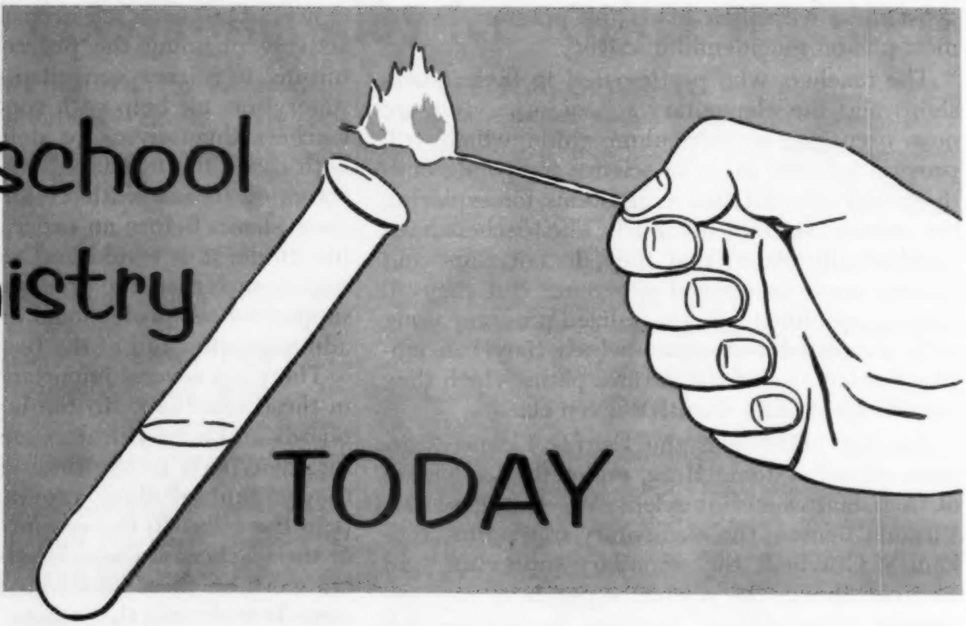
Another difference has been in the timing of the work. The Ossining group met in after-school sessions during the course of the school year. The Fairfax group did its major work in three annual June workshops, each of two weeks duration. In the case of the Fairfax group, teachers received extra remuneration for participating in the program. Also, a selection factor was involved since only a small number of teachers could participate and there were many more candidates than there were positions. Every Ossining teacher in the first three grades was urged to participate and almost all of them did. While these teachers received no direct and immediate compensation, they did receive in-service increment credit.

But there are many similarities in the kinds of programs being carried out in these two systems. In both cases, classroom teachers have been actively planning the programs and have been turning to science consultants and to the school supervisors for help with specific problems. The teachers themselves are doing the leading. In both cases, the teachers have been searching for activities to use with children and trying out their ideas. Before an experience is written into the guide, it is tested and explored thoroughly. And in each case, the program has had the active support—both professional and financial—of the administration and of the board of education.

There are several important things to be noted in these situations. In the first place, the school boards and administrators are to be commended for their parts in the programs. Not only have they organized these programs, but they have paid the bills. In the second place, the attitudes of the teachers are wonderous to behold. Teachers work on these problems with great enthusiasm. It is obvious that money is far from the only incentive since these teachers attend many, many meetings of committees where no salary credit or other personal gain is forthcoming. Furthermore, the teachers literally are planning for change. While there are written materials being produced, no one thinks of these as being gospel. Finally, there seems to be a direct correlation between the successful implementation of a science program and the number of teachers actively involved in building the program.

Fairfax County biology teachers review curriculum materials. (l. to r.)—Melvin Rose, McLean High; Mable Chapman, Falls Church High; Ilah Osborn, Haycock Elementary School; Vera Remsburg, Herndon High; Harry Keller, Annandale High.)

high school chemistry TODAY



By SISTER ERNESTINE MARIE

Science Teacher, St. Patrick's Convent, Quebec, Canada

WITH such a vast amount of newspaper talk, debate, and gossip centering around science today, one begins to wonder if the much maligned high school science teacher has really done anything about the "deplorable conditions." It might be well to assure the American public that many teachers are, in truth, well trained, cognizant of the situation, and have taken measures to improve secondary education in the sciences.

The particular object of this article is to show one new approach being used in the teaching of chemistry. Granted, the departure from the time-worn methods is not too drastic, but the necessity of preparing students for college entrance Board examinations requires the retention of much formality. Formality can have a definitely stultifying and restricting effect on vital science, and in many instances has caused subject-matter mastery to deteriorate into mere parrot-like memorization. It is difficult to capture a feeling of scientific zest in such topics as equation-balancing and gas laws, and these are but two of the very prosaic and mechanical requirements of the alarmingly dull list expected of students preparing for entrance into colleges.

If the teacher, however, but tries to give the matter meaning and makes it a study in understanding and problem-solving instead of a feat of sheer memorization, a great advance is made. Motivation is the heart of the learning process and today's student will do much better when given a problem to solve than when presented with a page to memorize. Interest is prerequisite!

Pupil-teacher goals for any high school chemistry course will include the following:

1. The student should learn CONCEPTS through organized thinking.
2. The student should develop some PROBLEM-SOLVING ABILITY.
3. The student should learn those particular SKILLS which are specific to chemical laboratory work.
4. Laboratory work should INCREASE OBSERVATIONAL POWERS and call attention to hidden meanings to be discovered in laboratory experimentation.
5. Students should see the PRACTICALITY, versatility, and great future of chemistry; APPRECIATE its impact on national economy, and be, in some cases, influenced to make chemistry a vocational choice.

But how are these goals approached in a common everyday high school chemistry course?

Having decided upon the traditional experiment of replacement of metals generally entitled "Electromotive Series" as the one to illustrate the new, modified-inductive approach, it will be necessary to follow through this section of laboratory work from start to finish.

1. *Collect the necessary materials:*

Na	Sn
Ca	Cd
Mg	Pb
Al	$HC_2H_3O_2$
Cu	HCl
Zn	H_2SO_4
Hg	HNO_3

(Note: All metals should be of the same type, i.e., all powder, or strip, or shot.)

2. *Perform the experiment:*

Test the reaction of Na and Ca with water using a minute quantity of the metal in a covered beaker. Test the products of reaction.

Using the suggested acids and metals, determine the relative ease with which a metal will replace hydrogen from an acid; compare the acids as well as the metals. Use dilute HCl as the standard acid against which to check metal reactivity. Test all products.

3. *Report the experiment as follows:*
   a. Arrange metals in descending order of reactivity.
   b. Arrange acids in descending order of reactivity.
   c. Balance equations for all reactions that occurred.

The directions given the student are minimal, hence, each student must find out the methods of testing for himself. Students are warned to be careful with Ca and Na. "Test the products of reaction" appears twice in this short guide sheet to impress this point—the student knows the reactants and he must proceed to discover positively the products he has so that he can write the proper symbols on both sides of the equation arrow. He puts sodium with water and identifies hydrogen gas by means of a burning splint, OH^- by litmus or other indicator, and Na^+ by flame test. He can then write with conviction and understanding:

$$Na + H_2O \rightarrow H_2 + NaOH.$$

If he knows the basic concepts of conservation which he should have grasped from classroom lectures, along with a realization of the diatomic nature of hydrogen gas, he will immediately see that he has more hydrogen as a product than went into his reaction as reagent. With some teacher guidance he can then write a correctly balanced equation.

In other laboratory testing he will add zinc to dilute H_2SO_4 and identify hydrogen gas by a burning splint, zinc ions by hydrogen sulfide precipitation, and sulfate ions by barium sulfate precipitation. He can then write:

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2.$$

But in addition he will also know that

$$BaCl_2 + ZnSO_4 \rightarrow BaSO_4 + ZnCl_2.$$

Moreover, he sees that $ZnSO_4$ is soluble whereas $BaSO_4$ is not, so that in this way solubilities of common chemicals will become part of his fund of ready knowledge.

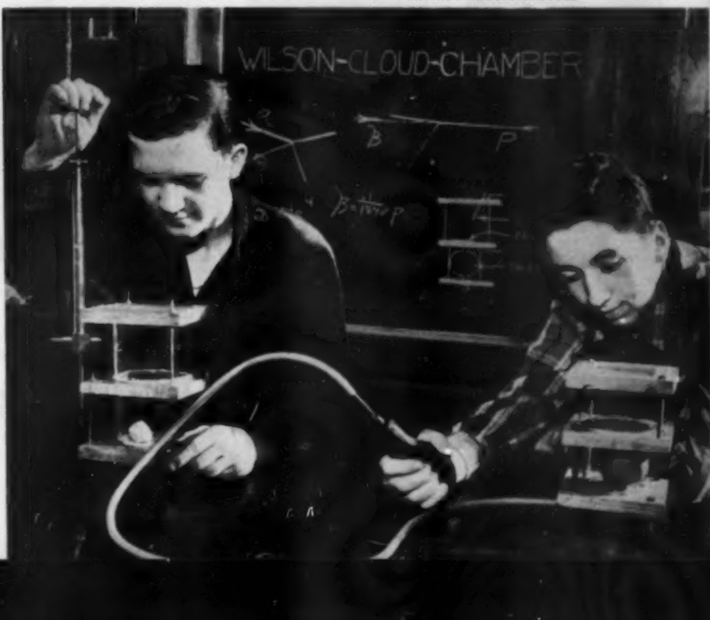
He has also, probably, discovered that small quantities of reagents can be handled easily and give him neat, clean, quick results. By trial and error he knows the value of clean glassware which will not contaminate his tests. He is gaining facility in handling stock reagent bottles and in manipulating his own glassware and burner.

He works with concentrated and dilute acids and finds that the concentrated ones are not quicker reactors, as he might have thought they were. This puzzle he will probably be unable to solve as yet, but he has developed a mental set, ready and receptive to the coming section on ionization tests.

He finds HNO_3 and concentrated H_2SO_4 do not behave like other acids with zinc and lead and other common metals. His burning splint test fails to identify the gaseous product. Perhaps he cannot write the equations involving these acids but will have to refer to a text to find the products that might be expected, and the tests for them. Very well, he has learned an important point that hours of classroom drill

Laboratory work requires particular skills and increase of observational powers. After materials or models are prepared, the student must test and evaluate his work and data obtained.

CHICAGO PUBLIC SCHOOLS



AO Reports on Teaching with the Microscope

From Oblique Prisms to Rhombic-based Octahedrons...or Cubism on the Stage Scope

Perhaps more than any single other form, the crystal never ceases to awe and impress. The formation of its distinctive geometric shape, which differs a thousand times over is a fascinating process to watch. Possibly this interesting experiment sent us by Mr. Breslau and Mr. Payenson will help you create sufficient student interest in the Microscopic world of Chemical Crystallography to encourage them to further study.

Of course, the criterion that determines what the student sees is the quality of the microscope's optical system. The AO Series 73 Student Microscopes have an excellent optical system coupled with a low price tag that makes it a very attractive buy for many schools. The single, easy-to-use focusing adjustment makes it ideal for classes where acquisition of subject matter is the primary concern. Rugged construction invites hard classroom usage...they are built to service the most active class for years.

EXPERIMENT

By: Abraham Breslau and Irving Payenson
Bushwick High School
Brooklyn, New York

"The recent 1957 Chemistry syllabus issued by the Bureau of Secondary Curriculum Development of the New York State Education Department includes a unit on 'Solutions and Near Solutions'. Topic III of this unit is on crystals, and includes such understandings as the geometric shape of crystals and the formation of crystals from solutions. A common procedure to illustrate these understandings is to demonstrate crystallization by cooling a hot saturated solution of a salt such as potassium nitrate in a test tube so that precipitation results. Crystal form may be shown by using models or a few specially grown crystal samples. The demonstrations have their limitations in their impression on the student. We believe that the following experiment overcomes some of these limitations".

OBSERVING THE FORMATION OF CRYSTALS FROM SOLUTION

MATERIALS AND PREPARATION

Copper sulphate, alum, sulphur, sodium chloride, carbon disulphide, small erlenmeyer flasks, stirring rods, slides, AO Spencer No. 73 Student Microscopes.

Each student will have a microscope and a single slide. The class is instructed to set up the microscopes to focus at low power of 100x (10x objective and 10x eyepiece) at any specks on the slide. The instructor can prepare the following materials at the demonstration table while the students are thus engaged.

Place a small erlenmeyer flask containing approximately 80ml. of a saturated copper sulphate solution and 5 grams excess solid on a tripod with gauze over a bunsen burner. Prepare similar flasks of alum and sodium chloride solutions. A clear solution of roll sulphur in 5 ml. of carbon disulphide is prepared in a stoppered test tube.

(CAUTION: Carbon disulphide is extremely inflammable. *Do not* heat the solution or place near open flame).

PROCEDURE:

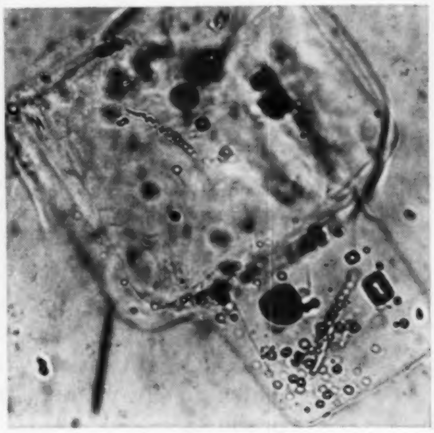
1. The students are directed to keep slide clamps off the stage and move the slide to the edge of stage. The microscope should not be tilted.

2. As soon as the copper sulphate solution starts to boil, the instructor picks up the flask with suitable means (pot holder or forceps) and, walks through the class placing a single drop of solution on each students' slide with a stirring rod.

3. The student immediately moves the slide under the objective and watches the drop, preferably at an edge, as it cools. Meanwhile, the instructor heats the second flask.

4. The procedure is repeated for the next salt solution, using a different spot on the same slide for comparison purposes.

5. After all burners have been extinguished, the instructor opens the sealed test tube and places a drop of cold carbon disulphide solution on each students' slide. From this, the student will observe sulphur crystals develop by evaporation.



Photomicrograph of sodium chloride crystal

OBJECTIVES:

1. The student is more impressed and usually more understanding of the basic concept of crystal formation and development. "He was there when it happened".

2. It demonstrates the process of crystal formation from solution by cooling.

3. It demonstrates the process of crystal formation from solution by evaporation.

4. Some idea of the many geometric crystals forms possible are graphically presented.

5. The student is exposed to a new and interesting field of study.

6. The term "precipitation" is meaningful and realistic.

This experiment can be performed with three substances in about twenty minutes with a class of thirty-five students. There is no difficulty in explaining the subject, performing the experiment, cleaning up for the next class and discussing the results in a forty minute period. Cleaning the slides is easily facilitated by passing a single facial tissue to each student.

Free 24 page booklet, "Elements of Optics", is yours for the asking. It offers a very practical way to introduce students to the fundamentals of color and light. The basic laws and theories of optics are clearly described and well illustrated. Get your copy of this 50 cent booklet, free. Just send your request to American Optical Company, Dept. V95, at address below. Ask for booklet number ST9. If you would like more information on the microscope used in this experiment, request brochure SBTI. There is no obligation, of course.

American Optical Company

Instrument Division • Buffalo 15, New York

generally fail to impart. And, if he consults a text to solve his problem, he has developed a sense of mastery—and a respect for and familiarity with his textbook.

Acquaintance with a common workbook type of manual will serve you as a contrast with the above method. The explicit directions, "To five test tubes in a rack, add ten ml H_2O and in the first put 2 drops of HCl and a piece of zinc the size of a pea . . . ." are missing; the blanks to be filled in with obvious answers are also missing. Gone are the days of the student reply: "I'm doing the second sentence of the fourth paragraph." A student stopped in midstream in inductive laboratory work must know what he is about or he could not have started. Is "follow-the-recipe" chemistry science? Does it make for interest and understanding? NO! It is mere mixing and cooking such as can be done by any half-moronic servant girl in the kitchen.

In what does the strength of the new departure lie? Precisely in its ability to pick up a student at that point of chemical knowledge to which he has already attained and to lead him on from there. His interest is kept alive; he is not fettered by the narrow bonds of precise directions from one book; he is free to test that phase of a topic in which he is most interested. He reports his findings in a chart or flow sheet or systematic outline. Laboratory work becomes a challenge directed to the discovery of facts unknown to the student rather than what it has too often been in the past—a mechanical demonstration and repetition of known facts. Classroom time can be spent entirely on theoretical chemistry when the laboratory takes over the descriptive branch of the science and in this way a far sounder foundation can be laid.

As was said at the start, this is but one method in use today, but it is one powerful way of training good future scientists, of arousing interest in science, and of challenging today's youth to achievements within their power but above their easy reach. It is a way to save our gifted youngsters from boredom and to rouse our lazy students from their lethargy. Multiply this one effort by one teacher by the many fine scientist-educators in America today and be assured that the youth in our schools will be taught well, and in the best American tradition, which, in the long run, will outdistance and eclipse the much vaunted authoritarian methods of Europe.

Introduction to ENZYME ACTIVITIES

By LEONA K. ADLER

Biology Teacher, Hunter College High School, New York City

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

THE most important progress in recent years in explaining the mechanisms of life has come about through work in the fields of biochemistry and biophysics. The interlocking relationships of enzymes, vitamins, hormones, antibiotics, antimetabolites, mechanisms of gene expression, and others have been a fascinating story of modern science. Biology courses have always included laboratory exercises which show some of these relationships. Experiments in digestion and fermentation, for example, have shown some aspects of enzyme activity. More could be done, however, to introduce modern knowledge in this field and to help the student to appreciate the multiplicity of chemical reactions in a living thing, the part that enzymes have in these reactions, the exquisite balance involved in chemical reactions, and the role of biochemistry in interpreting life activities. In an advanced biology course particularly, an understanding of the nature of enzymes is basic to an understanding not only of digestion but of respiration, nerve and muscle metabolism, photosynthesis, and the action of vitamins in the body.

The laboratory exercises described below illustrate several of the factors which are involved in enzyme activity: time, concentration of the enzyme, the influence of hydrogen ion concentration, the influence of temperature on enzyme action, specificity of enzymes, enzyme inhibition, inactivation of enzymes by boiling, and different types of enzymes.

These exercises involve a few of the important outcomes we expect of laboratory work. They help to develop habits of accuracy and careful observation, and most important of all, they invite further exploration in a field which still has a good deal of uncharted territory. These exercises are simple and straightforward, requiring no special apparatus or involved technique. Most of the experiments are done with saliva and starch, but other enzymes and substrates could be substituted for the ptyalin and starch used in this series, provided that quantitative measurements could

be worked out for them. It is best to divide the class into groups for this work and to pool the results for final class review.

A one per cent starch paste is used in this group of experiments. One gram of dry starch is mixed well with 3 cc of distilled water, then 97 cc of distilled water is heated to the boiling point and stirred into the starch mixture. The mixture is cooked for two minutes, stirring constantly, and it is then cooled to room temperature.

When starch is mixed with saliva, the progress of its digestion may be traced with iodine in potassium iodide solution. As digestion progresses, the color of the combination of the mixture and iodine will change from the blue of starch—iodide to shades of purple, red, orange to a pale greenish color. The intermediate colors between blue and the pale green indicate different types of dextrin. The latter color is known as the achromic point. As digestion progresses, the Benedict test may also be used to detect maltose, the end product. A porcelain test tablet, similar to that used by artists, may be used to determine the colors, or a series of depression slides or small watch glasses may be placed on white paper and the test droplets placed in these. The colors should be read quickly.

1. Time of Digestion

Place 25 cc of the starch paste in a beaker. Add 20 drops of filtered saliva. At intervals of two minutes remove about two drops of the mixture to a depression of the test tablet. Add two drops of I and KI solution with a special pipette, mix by moving the tablet slowly. Record the color of each sample. Record the time at which the achromic point is reached. Another student removes about three drops at a time to test tubes for three sugar tests. Samples of the starch-saliva mixture for this test are removed at the beginning of the experiment, at the red color point, and at the achromic point. To each sample, which has been placed in a test tube, a few drops of Benedict's solution are added, making sure that the mixture is washed down into the bottom of the tube. Heat gently to boiling point and record results.

2. The Effect of Temperature on Digestion of Starch by Saliva

Place 2 cc of starch paste in each of four test tubes. Place one tube in a beaker of water which is kept at 38° C, one in a beaker of water which is kept at room temperature, one in a beaker of ice and water, and one in a beaker of water which is kept boiling. The temperature of the *starch solution* must be recorded. The temperature of the *starch solution* in each case should be brought to the desired point and *kept there* throughout the experiment. When the desired temperature has been reached in each case, the experiment is begun; 1 cc of filtered saliva is added to each test tube. Samples are removed at four-minute intervals and tested as in experiment 1. Record the order of digestion.

3. The Influence of Dilution of Saliva on Digestion

Into each of six test tubes place 9 cc of water. Add 1 cc of filtered saliva to tube No. 1 and shake thoroughly. Transfer 1 cc of this to tube No. 2 and after mixing well, transfer 1 cc of this to tube No. 3 and continue until the following dilutions have been made: 1:10; 1:100; 1:1000; 1:10,000; 1:100,000; and 1:1,000,000. Add 1 cc of starch paste to each tube and mix thoroughly. Incubate in water bath at 38° C. After 10 and 20 minutes test by the iodine and Benedict tests.

4. The Influence of Hydrogen Ion Concentration on Salivary Digestion

Solutions of hydrochloric acid and sodium hydroxide are used. Starting with .1 Normal hydrochloric acid solution and .1 Normal sodium hydroxide solution, several dilutions are made using the transfer method described in the preceding experiment. The following HCl solutions are prepared in this way: .1N HCl; .01N HCl; .001N HCl; .0001N HCl; .00001N HCl; and .000001N HCl. A similar series of sodium hydroxide solutions is prepared: .1N NaOH; .01N NaOH; .001N NaOH; .0001N NaOH; .00001N NaOH; and .000001N NaOH.

(Continued on page 444)

NSTA CALENDAR

As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST's* calendar editor as early as possible.

October 29-30, 1959: Association for the Education of Teachers in Science, Teachers College, Columbia University, New York City

November 7-10, 1959: NSTA Conference on Selected Problems in Secondary School Science, Burlington Hotel, Washington, D. C.

November 8-14, 1959: American Education Week. Theme: Praise and Appraise Your Schools

November 26-28, 1959: 59th Convention, Central Association of Science and Mathematics Teachers, Chicago, Illinois

November 27-29, 1959: Regional Conference, Statler Hilton Hotel, New York City

December 26-31, 1959: NSTA Annual Winter Meeting with science teaching societies affiliated with the American Association for the Advancement of Science, Hotel Sherman, Chicago, Illinois

January 28-30, 1960: 29th Annual Meeting, American Association of Physics Teachers, Hotel New Yorker, New York City.

February 10-13, 1960: 33rd Annual Meeting, National Association for Research in Science Teaching, Chicago, Illinois

March 29-April 2, 1960: NSTA Eighth National Convention, Muehlebach and Phillips Hotels, Kansas City, Missouri

Classroom Ideas

General Science

A Teaching Experiment

By LEN HILLER, Papago Grade School, Phoenix, Arizona

Purpose of the lesson: To explain the terms atom, molecule, symbol, formula, element, and compound. To show how *some* elements are named and symbolized. To show how formulas are obtained and to give students practice in writing them. Class participation can be used to great advantage in presenting this lesson, but the teacher must make sure that he is guiding the discussion in the proper direction; it may even be given in the form of a lecture.

Equipment needed: One Tinkertoy set with parts painted as follows: several red, yellow, and blue parts of the same or different shape; several orange parts of each of three different shapes. A periodic chart may be used, but it is not necessary. The pupils will need pencil and paper.

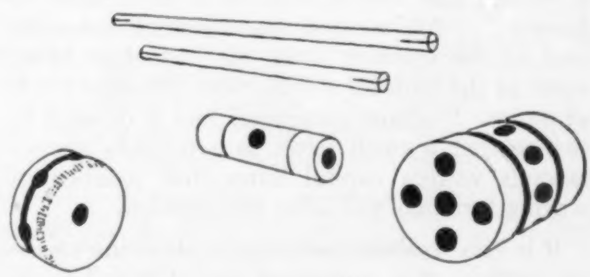
Procedure: Place a box on the desk containing the various parts and a few connecting pegs. Explain to the class that you are a chemist who is attempting to discover some of the "building blocks" of the world. After exhaustive tests you have been able to isolate several materials and you are convinced that each one is a single "building block" that is not combined with anything else. These materials are *Elements.*

Several of the elements were named because of their "obvious" characteristics. Hydrogen means "water maker"; nitrogen was originally named azote meaning "useless," and the name "radium" comes from "ray." Reach into the box and pull out a red part and name it "red" because of the color characteristic it has. A single red part is an *Atom* of the newly discovered element "red." It may be explained at this point that *Symbols* are often the first letter of the element. The symbol for the element "red" may be "R," which is always capitalized. Many examples of this method of determining symbols may be pointed out on the periodic chart.

Reach into the box and pull out a blue part. If the class is asked to name this new element, they should respond with the name "blue," and they should assign the element with the symbol "B."

Next pull out a yellow part. Explain to the class that you wish to name this element after the substance from which it came rather than because of a characteristic. Since it came from a block of wood, name it "blockium." Potassium and sodium were named for the materials from which they were isolated, namely caustic potash and caustic soda. When we assign a symbol to the new element "blockium," we find that if we assign it the first letter "B" it cannot be distinguished from the element "blue." In this case we may use the first two letters, and the symbol is then "Bl." It may be explained that elements may be designated by either one or two letters, and the second one is a small letter. Many examples may be pointed out on the periodic chart.

Next pull out one of the orange parts and assign the name "orange" and the symbol "O." When another orange part is taken from the box, confusion will arise since it is of the same color (characteristic) as the previous atom, but has a



different shape (another characteristic). Even though it resembles the element "orange," in some ways it is not the same and must have a different name. Call this one "orangium" and let the symbol be "Or" so that it will not be confused with the element "orange" whose symbol is "O."

When a third kind of orange part is pulled out, the class will realize that here is a third related element and the newest of the three. Suggest that sometimes the new elements are named for the place of their discovery, and call this one "roomium" since it was discovered in the classroom. Berkelium and Californium are two recently discovered elements that were isolated at the University of California at Berkeley, California. The symbol of the new element "roomium" will be "Ro" so that it will not be confused with the element "red" whose symbol is "R."

We now have named six elements: "red" ("R"), "blue ("B"), "blockium" ("Bl"), "orange" ("O"), "orangium" ("Or"), and "roomium" ("Ro"). This list of the elements and symbols may be put on the chalk board because the pupils may not remember them all, and they will need to use them later.

Explain to the class that several (two or more) elements may sometimes combine to form a *Compound*, and that the combination of the atoms will form a bigger "building block" which is called a *Molecule*. Manufacture a molecule by putting together with pegs, 1 blue part and 2 red parts. Explain that this is a molecule of a compound and the name is "blue diredide." Examples of compounds named by this method are carbon dioxide and sulfur dioxide. The *formula* for the new compound "blue diredide" is "BR_2"; just as the formula for carbon dioxide is CO_2 and the formula for sulfur dioxide is SO_2. Compounds are not all named in this manner, however. This is probably the best time to explain that the number "1" does not appear in formulas, and that a symbol that has no number is understood to have a "1." Make up several different molecules and let the students write the formulas. Make some of the molecules with three different kinds of atoms. Students sometimes find it difficult to realize that a small letter in a formula always belongs with a capital letter, but practice in writing formulas will solve this problem.

It is easy to show that a molecule is the smallest particle of a compound and if it is broken down (taken apart), it does not have the same atomic structure. It does not, therefore, retain its characteristics.

Conclusion: This lesson is designed for elementary pupils and falls far short of doing the whole job of explaining the combinations of atoms. No attempt is made to deal with valence or to show why cretain atoms combine and others do not. It does not show proper arrangement of atoms in a molecule, and does not explain completely how compounds are named. It does not explain how a chemist can be sure he has isolated an element. It is intended, however, to explain the meaning of the six terms: *Atom, Molecule, Symbol, Formula, Element,* and *Compound;* and to show how formulas are developed.

Physics

Interference of Light (Newton's Rings)

By JAMES E. CREIGHTON, Nathan Hale Junior High School, Norwalk, Connecticut

Interference of sound waves can be demonstrated easily by using two tuning forks of slightly different frequencies which will set up beats audible to a whole classroom. However, interference phenomena with light is not so easily shown without fairly elaborate equipment.

With two microscope slides a teacher shows in five minutes a beautiful example of Newton's rings. A couple of drops of water are placed between two glass slides which are then pressed tightly together and allowed to dry.

A clear pattern of irregular colored rings will appear in the glass. The alternate red, green, and blue lines give a beautiful rainbow effect and where the lines are close together the alternate dark and light bands of interference and reinforcement are plainly seen.

These slides will stay together tightly for years if handled carefully and can be passed around the class. If you are not able to produce the rings the very first try don't be discouraged, just try it again.

NSTA Activities

Board Meeting, 1959

The 1959 annual meeting of the NSTA Board of Directors was held July 1-3 in St. Louis, Missouri, President Herbert A. Smith, presiding. With all Directors or Alternates except one present, morning, afternoon, and evening sessions were held for a total of 27 hours of deliberations.

1. It was reported that over-all income in 1958-59 was 113 per cent of the budgeted amount and that despite heavy expenditures for the printing of publications, NSTA net worth had climbed to a new high of nearly $100,000 (including accounts receivable, inventories, and cash balances, both plus and minus, in operational and project accounts).

2. The Association published 28 issues (676 pages) of various periodicals during 1958-59, and published or reprinted 18 booklets ranging from 12 to 64 pages each. Also, 23 leaflets of one to 12 pages each were produced and printed.

3. Approval was given to recommendations of an *ad hoc* committee for a Future Scientists of America Club and individual youth activities program. (Detailed plans for activating the program are now being developed; suggestions as to gaps and needs to be filled and services that ought to be provided are earnestly requested from all NSTA members who care to offer them.)

4. Approval was given for the merger of NSTA's student publication, *Tomorrow's Scientists,* with *Science World,* now being published by Scholastic Magazines, Inc.

5. Official participation of NSTA in the Golden Anniversary White House Conference on Children and Youth to be held in March 1960 was approved.

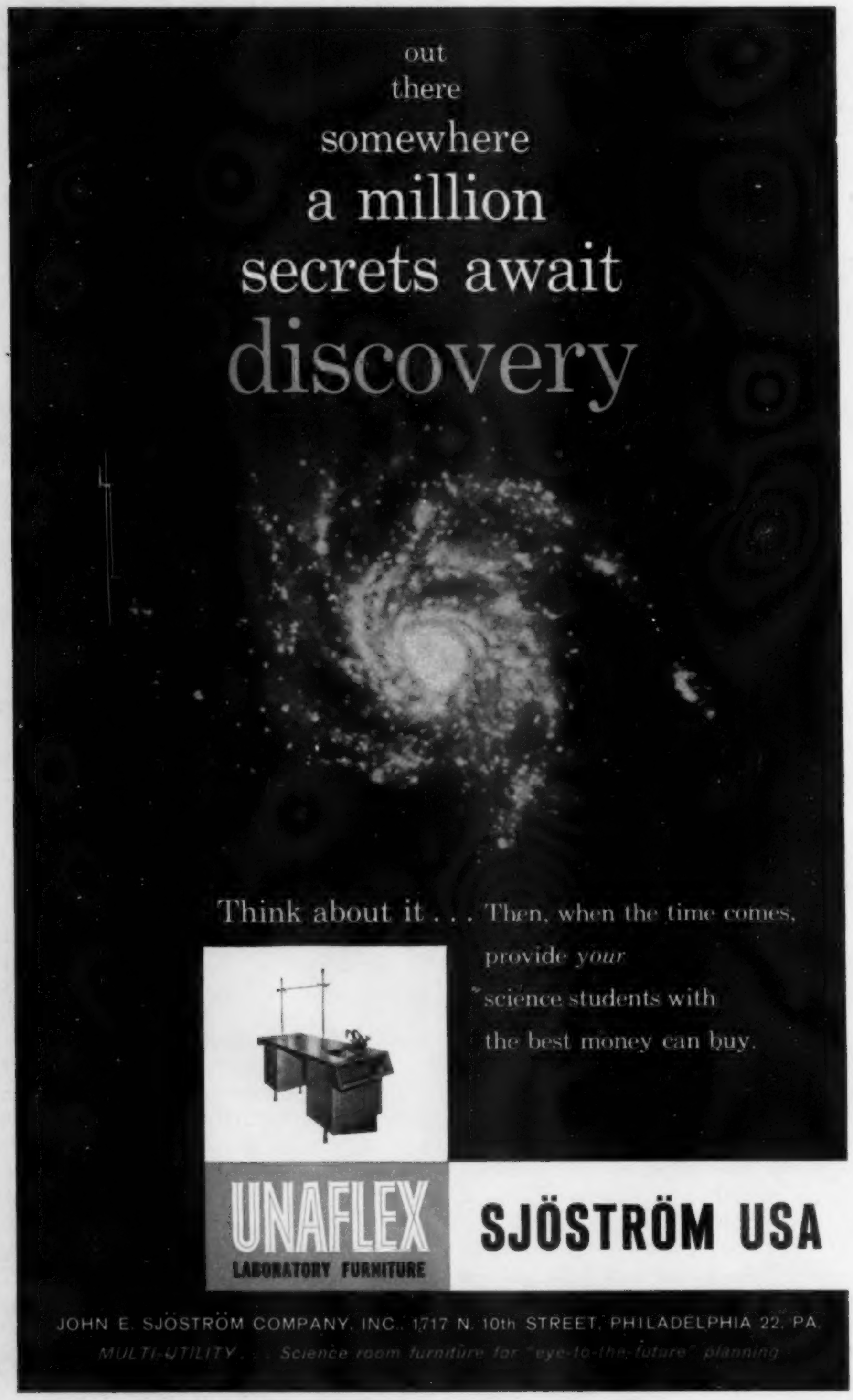
6. Approval was accorded for the formation of a Section for science supervisors, consultants, and coordinators within the framework of NSTA. Plans for this are being developed by a committee headed by Mr. Kenneth Vordenberg of Cincinnati, Ohio.

7. President-Elect Donald G. Decker was formally installed as 14th President of NSTA at 9:23 a.m. on July 3. He presented a proposed program, organization, and budget for 1959-60 that represented considerable departure from former practices. The main points in his proposal were: (a) that NSTA program be indicated more clearly to stem from Association policy goals and purposes; (b) that NSTA organize its activities into three categories, I. Science Education Activities for Youth, II. Professional Activities for Teachers, and III. Association Activities for Members; and (c) that the budget be designed and apportioned to indicate more clearly how it is serving the program of NSTA. The proposal was adopted as submitted.

8. The budget adopted for 1959-60 totals $429,000 of which only about $110,000 is anticipated from memberships and subscriptions. The budget provides for a headquarters staff of 24, including three professional, three editorial, and three administrative persons, and the rest comprising secretarial and clerical personnel. Included are authorized new positions of Associate Executive Secretary, Business Manager, Editorial Assistant, and one secretary. One Assistant Executive Secretary position was discontinued (or re-designed to that of Business Manager).

NSTA Staff Changes

In the new post of Associate Executive Secretary is Dr. John W. Renner who, with his wife Carol (a former secondary school teacher) and their two children, has taken residence in the nation's capital. Formerly Acting Head of the Physics Department and Assistant Professor of Physics and Education at Creighton University in Omaha, Nebraska, Dr. Renner has been active in many professional education activities, and has published a number of articles in science journals, including *The Science Teacher*. Dr. Renner completed his PhD Degree in Science Education at the State University of Iowa, and received his BA and MA Degrees in Physics and Mathematics at the University of South Dakota (1944-48). He attended the Public High School in De Smet, South Dakota (his native state). His teaching career has included positions at the Universities of South Dakota, Illinois, Creighton, and the State University of Iowa. During 1956-58, he was Director of the Radiological Defense School of the U. S. Office of Civil Defense Mobilization (Michigan).



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In the position of Business Manager is Mr. George A. Crosby who, with his wife Marilyn and their three children, resides in Landover Hills, Maryland. Currently, he is completing work on his MA Degree in Education at the University of Maryland. His undergraduate work was at the University of Maryland (1946-48), and at American University, Washington, D. C. (1953-55); and he attended Southern High School in Lothian, Maryland. Having held teaching posts in social science studies for grades 8-9 in Prince Georges County, Maryland, he also has had the added experience of business management in private industry.

B-I Section Officers

Affairs of NSTA's Business-Industry Section are conducted by an Executive Committee chosen at the annual meeting held in conjunction with the NSTA convention. Those elected in Atlantic City are as follows. Terms expire in the spring of years indicated in parentheses.

Julian Street, Jr., *Chairman* (1960)
Educational Aids and Technical Public Relations
United States Steel Corporation
New York City

Earl Whitcraft, *Vice-Chairman* (1963)
Educational Services, Public Relations
Socony Mobil Oil Company, Inc.
New York City

Catherine Ready, *Secretary* (1963)
Educational Services Department
Bristol-Myers Company
New York City

John P. McGill, *Treasurer* (1962)
National Committee on Education
American Trucking Associations, Inc.
Washington, D. C.

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Public Relations Department
E. I. du Pont de Nemours and Company, Inc.
Wilmington, Delaware

Marion E. Jones, *Member-at-Large* (1960)
Kimberly Clark Corporation
Neenah, Wisconsin

Adler . . . from page 433

Into each test tube 4 cc of the test solution are placed. There will be 12 tubes in this series, tubes containing 4 cc of each of the solutions prepared above; a 13th tube with 4 cc of water. To each tube add 2 cc of starch paste and 2 cc of saliva. Place in a water bath at 38° C. At 10 and 20 minute periods, test with iodine and Benedict tests.

5. Inactivation of Ptyalin by Boiling

Boil 5 cc of filtered saliva for 20 minutes. Dilute up to original volume with distilled water. Prepare two test tubes. Into each place 2 cc of starch solution. To one tube add 1 cc of boiled saliva and to the other add 1 cc of unboiled, filtered saliva. Test at intervals, as before, after incubation at 38° C in a water bath.

6. Inhibition of Ptyalin Action by Salt of Heavy Metal (Mercuric Chloride)

Place 2 cc of starch solution in each of four test tubes. Add 1 cc of filtered saliva to each. To tubes Nos. 1 and 2 add respectively, 1 cc and 2 cc of .1 per cent $HgCl_2$ solution. To tubes Nos. 3 and 4 add respectively, 1 cc and 2 cc .1 per cent NaCl solution. Incubate in water bath at 38° C and test at intervals as above.

7. Specificity of Enzyme Action

Several different enzymes may be obtained, such as rennin, pepsin, urease, and diastase. The action of these enzymes on starch solution may be tested using the method outlined above and making similar dilutions of each of the enzymes with distilled water.

8. Different Types of Enzymes

The action of enzymes is extremely varied. There are hydrolases, for example, which split molecules and add water to them. The breakdown of starch is an example of this. There are dehydrolases which do the opposite. There are oxidases which add oxygen (or remove hydrogen) and there are reductases which do the opposite. In order to widen the acquaintance of the student with the different types of enzymes and to change his limited association of the word "enzyme" with "digestion," several different kinds of enzymes should be shown. Urease breaks down urea into carbon dioxide and ammonia. Urease can be added to urine, incubated

and tested with phenolphthalein against a control to which no urease has been added. Potatoes, which have an enzyme called tyrosinase, blacken if they are cut and exposed to air. This is due to the oxidation of tyrosine to a black oxidation product in the presence of tyrosinase. Every housewife knows that the potatoes do not blacken if they are peeled and covered with water so that they are not exposed to air. Some of the enzyme inhibitors used by housewives are interesting. Lemon juice is one such inhibitor, which prevents blackening partially because of another co-enzyme it contains, ascorbic acid. The action of yeast in fermentation is another example of enzyme action. Zymase in yeast changes sugars into ethyl alcohol and carbon dioxide. This can be set up in fermentation tubes and the presence of both end products can be measured as the substrate diminishes. Another enzyme whose action is discovered by housewives is that of bromelin, a proteolytic enzyme found in pineapples. Any housewife who attempts to make gelatin dessert with fresh pineapple in it finds that her gelatin does not set. It remains liquid because the gelatin is broken down by the action of bromelin. If the pineapple is cooked this does not happen because the bromelin is destroyed by boiling, and the fruit may then be used.

9. Reversibility of Chemical Reactions

A strange occurrence may have been noticed by teachers whose classes have tested for ascorbic acid with indophenol (2,6-dichlorobenzenoneindophenol). After indophenol has been changed from blue to colorless by the action of ascorbic acid, it seems to change back slowly to a very pale blue upon exposure to air. It is interesting to point out to students that theoretically the chemical reactions that are catalyzed by enzymes can reverse, but they are often kept from reversing because the end products are removed in certain situations. For example, after digestion, the end products of digestion are absorbed into the blood stream and taken to other sites where they may undergo further chemical change; or the end products may be passed from enzyme to enzyme.

In the class work which accompanies these experiments, it is interesting to trace the progress of theories of enzyme action and to read about the work of Bayliss, Michaelis, Warburg, Szent-Györgyi, and others. It is a fascinating story of progress in biology through progress in chemistry.

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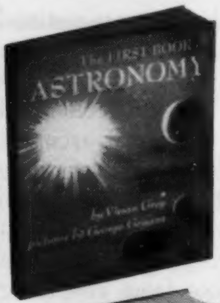

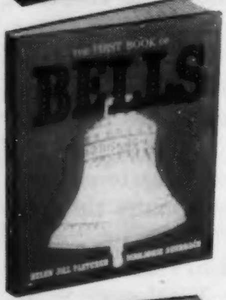

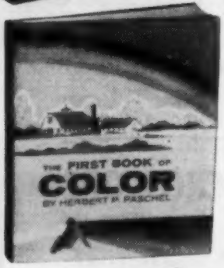

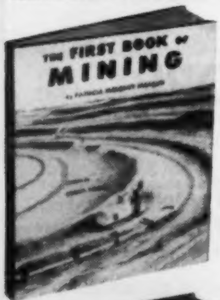

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Bleifeld . . . from page 410

teacher frequently reads aloud what the pupil has written, and rates it, instead of expecting the pupil to explain his work and to call on the other pupils of the class who could be ready to evaluate, to correct, or to disagree.

Are students encouraged to ask questions during a lesson? If so, how are the questions answered? By the teacher himself? Or, are the students encouraged to answer them? Are most points elicited from the class, or does the teacher spend the time lecturing? If the teacher starts out by eliciting ideas from the class about a demonstration, he will often eliminate the wrong ideas without giving the class a chance to try them out and discover for itself that they are not correct. He may make it the custom to give the homework assignment either at the beginning or the end of the lesson, instead of asking the class to suggest what the homework should be, now that the lesson has progressed to a particular point of special subject matter.

As a result of being exposed to such teacher-centered procedures year after year, the pupil falls into an educational lethargy in which he aims only to fulfill the expectations directed of him—to answer the teacher's questions, to do the homework assigned by the teacher, to follow the steps planned for him in the laboratory manual. In short, to do everything but to think for himself. Oh yes, he may think *about* the questions posed by the teacher, *about* the situations prepared by the teacher—but rarely does he undertake to suggest his own questions, plan for himself, or decide for himself.

This type of approach retards the development of the scientific attitude. It might seem anomalous to point out that much of the teaching that goes on in science classes is of this variety, and actually accomplishes a great deal in discouraging the growth and development of the scientific attitude in most students.

The heart of most teaching is the daily meeting of the class. This can truly be inspiring if it goes beyond mere lecturing or an elementary regurgitation of facts, and approaches the level in which the students are involved in thought-provoking questions and situations. If a teacher wishes to have his pupils participate in problem-solving situations in science, it is obvious that he must draw the curtain on the teacher-centered stage, and help the pupils move into an atmosphere where the spotlight is on them.

Readers' Column . . . from page 389

of the best physics teachers I know continually stresses, "Physics is the world about us." Her pupils are interested, and they do creditably in their college science courses.

3. High school science courses should teach "plug-in" problems. This idea has become almost heresy to some science teachers, but our high school pupils study algebra for two years, learning how to manipulate numbers and letters that stand for numbers. Why then should we tell them in physics and chemistry, "No, don't use your algebra. Think the problem through, even if this method takes longer and is more difficult. It is better for you"? Of what value then is their algebra?

4. The laboratory work is too time-consuming in its preparation. The teachers in one Academic Year Institute I know of have spent nine laboratory hours constructing ripple tanks (and most of the parts were pre-fashioned to start with), plus extra time of their own, and still are not finished. Moreover, I can't see the value of weighing objects on a soda-straw-and-pin balance. Why not learn to use a trip scale, or, better still, an analytical balance? The laboratory work in PSSC seems to reflect the independent work that is desirable in college courses. High school pupils need more direction and supervision, a big consumer of teacher time. (See next page)

5. The course is predicated on an educational Utopia, which is a long way off in most public schools. Among the prerequisites are:

a. A physics teacher who is paid enough so he doesn't have to work after school or in summers, who can devote these hours to better prepare his teaching and his knowledge of physics.

b. The physics teacher instituting the PSSC course should be relieved of one-fourth to one-half of his conventional teaching assignments and other duties.

c. Classes should be kept small; twenty to twenty-five pupils is the maximum.

d. Pupils of high academic talent should be sectioned separately from the others for the course in physics.

Although conditions *c* and *d* can be met in some schools, I cannot foresee conditions *a* or *b* being granted in the school where I teach. I can't even get *d*. It would seem that PSSC has never heard of a pupil-teacher ratio nor tried to buck up against "the facts of life" in large city high schools.

There are two minor annoyances about the PSSC course. The first is the implication that people who go in for high school teaching are not too bright or they would not want to teach at this level. These teachers, it is implied, must be shown by the superior teachers (who teach in college, preferably graduate courses) what to teach and how to teach. This attitude does not conform to my experience or that of many high school teachers.

A second irritation is the exaggerated stories told by some teachers of the new course. According to one teacher, "The pupils must be chased out of the room at the end of the period," so reluctant are they to leave. Another report has it that the teachers of other subjects in a certain school complain that pupils do not do their school work or homework in these subjects because they are so interested in physics.

In conclusion, I agree that there is need for a revised course in physics. Every course taught by every teacher should be under constant revision, individually or in consultation with other qualified persons. Revision in physics is overdue and should be drastic, in light of the great strides made by physics in recent years. I am not "sold," however, on the PSSC course as the answer to this need. I believe the revising should be done primarily by those who are familiar with the teaching situation in which the course will be presented—and college teachers have only a vague concept of the problems met by high school teachers. I certainly do not see the need for the almost religious fanaticism with which some physics teachers advocate and approach the PSSC course.

I invite criticism of my views through the columns of this magazine. I am confident my opponents will write. Are there other physics teachers who feel as I do?

WILLIAM BARISH
Jenkintown, Pennsylvania

Book Reviews

THE ROAD TO MAN. Herbert Wendt (translated by Helen Sebba). 431p. $5.95. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1959.

This book was originally published in Switzerland under the title *Wir und die Tiere*. The English title is intriguing though misleading by implying the path of human evolution. For the most part, the book is a verbal and pictorial journey through the animal kingdom in a necessarily cursory fashion. There are over 200 superb photographs.

The book is divided into five main sections (29 chapters): Mother Ocean, The Leap to the Mainland, Into the Atmosphere, The Conquest of the Great Open Spaces, and From Instinct to Thought. The organization is rather loose and somewhat encyclopedic.

In the first section, Wendt postulates on the origin of living organisms in the "mother of life," the ocean. Then the attention shifts to marine forms of life with emphasis on the bizarre creatures. Appropriately, this section closes with a recapitulation on the discovery of the ancient coelocanths off the coast of Africa. Then the book moves on to the amphibians and reptiles—again the emphasis being on the spectacular forms. In section III (Into the Atmosphere), groups as diverse as insects, spiders, birds, and bats are included. The scene then shifts to the open plains dwellers with the African mammals dominating the stage although there are short excursions into other land areas and into the sea. The final section is devoted almost entirely to mammals other than those previously considered. The last two chapters deal with the anthropoids. The human-like behavior of our "cousins" is cleverly elucidated.

The book is obviously intended for the layman and no special background is required in order to enjoy this book thoroughly. Although denied by the author, there is a generous sprinkling of anthropomorphism interwoven in various parts. Occasionally a fairly strong teleological flavor will be detected by a critical reader. Certainly, high school students and many junior high students will find this a fascinating book. Wendt has succeeded in getting away from stuffy morbid prose and has injected life into his descriptions.

HARVEY FEYERHERM
Northern Illinois University
DeKalb, Illinois

LIVING EARTH. Peter Farb. 167p. $3.75. Harper & Brothers, 49 East 33rd St., New York 16, N. Y.

This is an interesting and readable, yet scientifically accurate, discussion of life in the soil.

Author Farb, noted science writer, shows how the countless billions of organisms that live in the topsoil make it "alive," and indirectly, how they aid soil conservation.

"Earth is not soil unless it is inhabited," Farb says as he describes how the plants, animals, bacteria, insects, and fungi add fertility to the soil as they compete and cooperate in a never-ending struggle for life.

Described are slime molds, naked masses of protoplasm which reproduce by spores; mycorrhizal root systems, in which fungi process nutrients for tree roots; ants which raise fungus crops; wasps that paralyze tarantulas to provide food for their own young; and many other stories which illustrate the complexity of soil life.

Although forest, grassland, and desert soils are discussed separately, the text is integrated into a well-organized whole, partly by covering organisms common to all three soil types.

The material can easily be understood by people with no background in soil science. The book is valuable supplementary reading for students of high school age and up.

Because it is both interesting and accurate, high school science and biology teachers will find the book useful in their classes.

C. W. MATTISON
Conservation Education Association
Silver Spring, Maryland

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee
Dr. Robert A. Bullington, Chairman
Northern Illinois University, Dekalb

BOOK BRIEFS

PLANTS THAT HEAL. Millicent E. Selsam. $2.50. William Morrow and Co., Inc., 425 Fourth Ave., New York 16, N. Y. 1959.

This small book indicates the diversity of plant life and includes matter-of-fact accounts of the discovery and uses of medicinal plants. Man's concern with medicinal plants is traced from ancient ritual to modern plant exploring. The ancient Doctrine of Signatures and the physiology of today provide the background against which the stories of *Ephedra, Rauwolfia, Cinchona,* mandrake, ginseng, and others unfold. Well illustrated with drawings. Suitable for grades 5-10.

THE EDGE OF THE SEA. Rachel Carson. 238p. 50¢. The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. 1959.

Mentor reprint of a 1955 book which should be available to every biology student. An expert biologist and author, Miss Carson takes the reader on a fascinating visit to the seacoast from Maine to the Florida Keys and tells an intimate story of the myriad of creatures found there. 160 illustrations.

HOW LIFE BEGAN. Irving Adler. 128p. 35¢. The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. 1959.

A Signet Key reprint of a 1957 publication. Simplified discussion of the nature of life, the chemistry of living material and life processes, and probable origins of life. Valuable for high school students.

PURCHASE GUIDE FOR PROGRAMS IN SCIENCE, MATHEMATICS AND MODERN FOREIGN LANGUAGES. Council of Chief State Officers. 336p. $3.95 list; educational discount. Ginn and Company, Statler Building, Boston 17, Mass. 1959.

Specifications and advice on the purchase and educational use of 954 selected items of equipment for instruction in science, mathematics, and modern foreign languages. Discussions of special problems in the use of this equipment. Extensive annotated bibliographies of material for teachers and students.

ORGANIZATIONS IN THE EDUCATION PROFESSION. John M. Groebli. 495p. Doctor's Dissertation. Dept. of Curriculum, Teaching, and Supervision, Graduate School, George Peabody College for Teachers, Nashville, Tenn. August 1958.

Descriptive portrayal of America at mid-twentieth century including society and education. Notes the present status of organizational complex in educational professions at national level, and proposes plan of development for national organizations.

GEORGE WASHINGTON CARVER. Henry Thomas. 126p. $2.50. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1958.

The fascinating life of Carver is related in a most readable style. Early life, struggle for education, experiments, and life work are interestingly portrayed. Carver's many talents, gentle warmth, and humor are told in a way that would give the young reader an appreciation for this man of science. Very suitable for middle and upper grades.

ELEMENTS OF BIOLOGY. Ruth A. Dodge. 740p. $5.52. Allyn and Bacon, Inc., 150 Tremont St., Boston 11, Mass. 1959.

This book is an excellent revision of the work of the original authors William M. Smallwood, Ida L. Reveley, and Guy A. Bailey. It forms a part of the Allyn and Bacon 12-year science program.

Elements of Biology is a basic text for high school general biology yet appears extensive enough to meet the requirements of the college preparatory course. It has five major parts: Principles of Biology, Biology of Animal Life, Biology of Man, Biology of Plant Life, and Biology Past and Future. Each part is further organized into units which are introduced by preview pages and profusely illustrated with excellent, text-integrated line drawings and photographs.

Units are divided into chapters. Each chapter ends with aids designed to improve independent study. These

include glossary words, questions, tests, practical projects, and additional references geared to different reading levels.

Plants and animals are presented in an orderly progression, from simple to complex, with sufficient information to permit laboratory study without a workbook, if the teacher so desires. A chapter on Vocations in Biology seems especially significant at a time when we are trying to get our teen-agers interested in science as a lifework. A new 1959 laboratory-workbook and a new set of tests to accompany *Elements of Biology*, plus teacher's manuals for all three, are in preparation.

Let's Go to a Planetarium. Louis Wolfe. 47p. $1.95. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1958.

For ages 9 and up. Describes a trip through a planetarium. Excellent illustrations to capture the interest and imagination of youngsters. Simply written, contains a useful glossary of astronomical terms. Back cover contains ideas for correlated activities in English, arithmetic, social studies, art, and science.

Volcanoes and Glaciers. Sturges F. Cary. 95p. $2.50. Coward-McCann, Inc., 210 Madison Ave., New York 16, N. Y. 1959.

Descriptive treatment of Iceland. Volcanic structure and use of hot springs interestingly depicted. Glaciers and their work, agriculture and fishing are other features. Illustrated with photos and maps. For elementary grades.

The Story of Zeta: Man Made Sun. J. D. Jukes. 132p. $2.75. Abelard-Schuman, Inc., 404 Fourth Ave., New York 16, N. Y. 1959.

This is a most interesting description of the work being done with experimental thermonuclear power machines of the Zeta series. Stresses man's need for a new and efficient fuel supply. Excellent treatment of electricity, radiation, and the problem of releasing the nuclear energy of deuterium. Simplified line illustrations promote understanding. Suitable for junior and senior high school.

Wild Folk in the Desert. Carroll Lane Fenton and Evelyn Carswell. 128p. $3.50. The John Day Co., 210 Madison Ave., New York 16, N. Y. 1958.

This publication is suitable for young people, ages 4 to 12, and is the sixth in a series. It describes five great deserts in western North America and, through interesting narratives, introduces the reader to the plants and animals inhabiting them. The book is highlighted by 90 excellent individual drawings.

Wonders Under a Microscope. Margaret Cosgrove. 62p. $2.95. Dodd, Mead and Co., 432 Fourth Ave., New York 16, N. Y. 1959.

The junior scientist who wishes to explore the invisible world will find this a valuable guide. Covers use and care of a microscope, techniques of collecting material, and methods of preparing various kinds of slides. Numerous drawings by the author illustrate many items of interest that may be studied. Brief history of discoveries by famous scientists is included.

Educational Displays and Exhibits. J. Preston Lockridge and Gerda McMurry. 47p. $2. The University of Texas, Visual Instruction Bureau, Austin 12, Texas. 1959.

Provides helpful suggestions for educational displays and exhibits in the classroom, school fairs, and public places. Covers bulletin boards, various types of exhibits, and dioramas.

Solving the Scientist Shortage. David C. Greenwood. 68p. $2. Public Affairs Press, 419 New Jersey Ave., S.E., Washington 3, D. C. 1958.

The author discusses the nature of the much-publicized shortage of scientific manpower, and analyzes the present educational outlook. Describes the various programs to meet the need—governmental, private, and professional. Recommendations for alleviating the shortage are offered to industry, government, and to educational institutions. Educators will find these a real challenge.

Dust. Irving Adler. 118p. $3. The John Day Company, Inc., 210 Madison Ave., New York 16, N. Y. 1958.

Covers the subject of dust in the atmosphere and its effect on daylight, weather, soil, climate, and health. Important aspects covered in an interesting fashion are cosmic dust, the live organisms in dust, and relationship of dust to health. Suitable for upper grades.

Pigs, Tame and Wild. Olive L. Earle. 64p. $2.50. William Morrow and Company, Inc., 425 Fourth Ave., New York 16, N. Y. 1959.

Any child in the middle or upper elementary grades will enjoy this informative book on the domestic pig and its wild relatives. It gives a clear picture of the pig and its importance to man. Well illustrated with drawings.

Helicopters to the Rescue: How the Amazing "Whirly-Birds" Do the Impossible. C. B. Colby. 48p. $2. Coward-McCann, Inc., 210 Madison Ave., New York 16, N. Y. 1958.

An outstanding pictorial and descriptive report of the versatility of the helicopter. Action photographs show the amazing amount of work accomplished by this aircraft in many situations. It will be readily accepted by the junior high school student in his quest for the new and adventurous world.

PROFESSIONAL READING

"General Education for Teachers." Temple University, Philadelphia 22, Pa. 1959. *Pilot Study 1 of an Experimental Program in Teacher Education*, this 166-page report was conducted by Temple University in cooperation with five other Pennsylvania colleges. It reports on a program developed for teachers in both elementary and secondary schools to help them meet the current problems in education. The courses were designed as a desirable compromise between further academic specialization and obtaining credits in higher education, and lead to a Master of Science in Education Degree.

"Science for All Children and Youth." By Willard J. Jacobson. *Teachers College Record,* 60:318. March 1959. Science programs (1) should provide children and youth with opportunities to explore, (2) should be flexible to allow consideration of problems of current interest, and (3) should use, in each problem, the approach most consistent with that problem.

"A Guide to Vocations in Engineering and Related Fields." By Lynn L. Ralya and Lillian L. Ralya. University of California Extension, Los Angeles. 1959. Provides referenced and detailed information for teachers of science and mathematics who are concerned with vocational futures of their students.

"An Experimental Summer High School Program." By Don D. Longnecher, Dorothy M. Herbst, and Dorothy F. Kavanaugh. *Educational Bulletin,* 38:113. May 13, 1959. An account of how the program was planned, carried out, and evaluated. Subjects include Advanced Chemistry, Advanced Science and Mathematics, and Advanced Biological Science.

"Plankton biology and . . . the Development of Atomic Energy." By Bostwick H. Ketchum. "New Discovery in Physical Oceanography." By C. O'D. Iselin. *Oceanus,* 6:5-13. 1959. Both articles give an up-to-date account of research in the field of oceanography; the first covers plankton ecology, and the second describes discovery of a swift current recently located in the Pacific.

"Science Programs and the Development of Scientists." By James G. Harlow. *Teachers College Record,* 60:306. March 1959. Administrative difficulties, rather than curricular ones, may be the real basis of science education problems.

"Artificial Satellites and the Earth's Atmosphere." By Robert Jastrow. *Scientific American,* 201:37-43. August 1959. Data on the earth's upper atmosphere from an analysis of satellite-orbit information.

"Indiana's Unspoiled Dunes." By R. M. Strong. *National Parks Magazine,* 33:6-7. August 1959. A description of the world famous (scientifically) dunes, and a commentary on their value.

"Ocean Waves." By Willard Bascom. *Scientific American,* 201:75-84. August 1959. The motions of the oceans, generation and propagation of waves, are described from early research studies to the present century.

APPARATUS AND EQUIPMENT

LIGHT POLARIZER KIT. Contains a cardboard tube about 8 inches long with a protractor scale near each end, two end caps, two mountings (cardboard) for polaroids, two polaroids, and various cardboard rings of several colors, and plastic and metal objects. A pamphlet gives excellent directions for assembling the apparatus and for a number of very good experiments in polarization of light. If carefully used this polarizer assembly should last for several years. It is recommended for use from about the 5th grade (in the hands of a teacher who knows a little science) through general physics in college. $2.25. 1959. Science Materials Center, 59 Fourth Ave., New York 3, N. Y.

AUDIO-VISUAL AIDS

SIMPLE PLANTS: BACTERIA. Presents a good description of bacteria. Shows major characteristics as well as excellent laboratory procedure concerning growth, morphology, and staining reactions. Technical aspects of the film are excellent. 13½ min. Color $137.50, B&W $75. 1958. Coronet Films, Coronet Building, Chicago 1, Ill.

INSECTS AROUND US. Designed for nature study in the early elementary grades but useful at higher levels. The set includes "Finding Out About Insects," "Insect Homes," "How Do Insects Protect Themselves?", "Our Insect Enemies and Insect Friends," and "Collecting Insects." Set of five filmstrips. 106 pictures in color. 1958. $24.50. The Jam Handy Organization. 2821 E. Grand Blvd., Detroit 11, Mich.

MEET THE MONARCH. A wall chart of the Monarch butterfly. Produced in realistic colors on stock which is water and wrinkle resistant. Accurate and appealing. Metal strip binding with eyelets for hanging. $5.95. Edwin C. Udey, Box 25761, Los Angeles 25, Calif.

HYDROGEN. A valuable supplement to discussion in high school and college chemistry. Covers historical aspects of hydrogen as well as modern industrial uses and the principle of the hydrogen bomb. Includes familiar demonstrations with hydrogen. 13½ min. Color $137.50, B&W $75. 1959. Coronet Films, Coronet Building, Chicago 1, Ill.

HEAT, LIGHT AND SOUND. An excellent and well-developed set of seven color filmstrips suitable for upper elementary and junior high grades. Films show clearly the fundamental principles of heat, light, and sound. Topics covered are The Cause and Nature of Heat, How Heat Causes Expansion, How Heat Travels, Light and Color, The Cause and Nature of Sound, and How Sound Travels. 254 frames. Set $31.50, single $5.75. 1959. The Jam Handy Organization, 2821 E. Grand Blvd., Detroit 11, Mich.

INSECT FOODS. The feeding habits of insects are vividly portrayed in excellent close-up color photography. Included are the feeding stages of the katydid, grain beetle, Polyphemus moth, wasp moth, termite, carpet beetle, clothes moth, flea, praying mantis, and ant lion. Various stages of life cycles are shown. The place of the species in the balance of nature is emphasized. A non-technical film of considerable value for upper elementary and high school classes. 14 min. Color $135. 1959. Pat Dowling Pictures, 1056 S. Robertson Blvd., Los Angeles 35, Calif.

ROCKETS: PRINCIPLES AND SAFETY. Suitable for upper elementary through high school science classes in which rocketry is being introduced for the first time. Discusses the development of the jet and rocket principles graphically and simply. Includes an important section on rocket safety for amateur rocketeers. Excellent narration and photography. 11 min. Color $110, B&W $55. 1959. Film Associates of California, 10521 Santa Monica Blvd., Los Angeles 25, Calif.

LITTLE ANIMALS. Designed for use in a primary science program. Excellent for introducing basic concepts on size of animals and various senses they use. Includes good thought—questions and introduction of new vocabulary words. 11 min. Color only, $110. 1959. Pat Dowling Pictures, 1056 S. Robertson Blvd., Los Angeles 35, Calif.

ELEMENTARY CHEMISTRY GROUP. Filmstrips: "What Things Are Made Of," 43 frames; "Chemical Changes," 42 frames; "Atoms and Molecules," 46 frames. Designed to accompany unitexts of Row, Peterson's Basic Science Education Series, but may be used independently of these books. If used in unison and with guide, expansion of the subject can be treated for teaching basic concepts of chemistry to grades 6 through 8. Color. Set with guide, $16.20. 1958. Row, Peterson and Co., 1911 Ridge Ave., Evanston, Ill., and Society for Visual Education, Inc., 1345 W. Diversey Parkway, Chicago 14, Ill.

(See next page)

THE HUMAN BODY: DIGESTIVE SYSTEM. By animation and photography the structure and function of all parts of the human digestive system are clearly shown. The path of food is traced and the changes made in it are described. For senior high school. 13½ min. Color $137.50, B&W $75. 1958. Coronet Films, Coronet Building, Chicago 1, Ill.

THE HUMAN BODY: REPRODUCTIVE SYSTEM. This film will be an important contribution to aids for teaching the structure and functions of the human reproductive system. Simple and clear diagrams show the structure of male and female systems. Photomicrography shows live human sperm and ovum, the penetration of the ovum by sperm, and the dividing zygote. Does not show embryonic development beyond this point. Recommended for showing to separate groups of junior and senior high students. 13 min. Color $137.50, B&W $75. 1959. Coronet Films, Coronet Building, Chicago 1, Ill.

HECTOR REPORTS: To answer some of your recent requests, we do have available the major addresses given at the Science-Economics Workshop at Sarah Lawrence College in August 1958, co-sponsored by NSTA, the Joint Council on Economic Education, and the National Council for the Social Studies. Entitled *The American Economy: An Appraisal of Its Social Goals and the Impact of Science and Technology,* you may send in orders directly to NSTA, and *NOT* through the Publications-Sales Section of NEA. Please send payments with your orders. (156p. $2.)

Just off the press is *A Summary Report of Proceedings of the Seventh National Convention,* NSTA, held at Atlantic City in 1959. Edited by Hugh Allen, Jr., of Montclair State College, it is a thorough and complete edition of the convention activities. Those who placed orders at the convention will receive their copies at the pre-publication price announced at that time. Orders should be sent directly to the Publications-Sales Section of NEA. (54p. $2.)

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